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POWER

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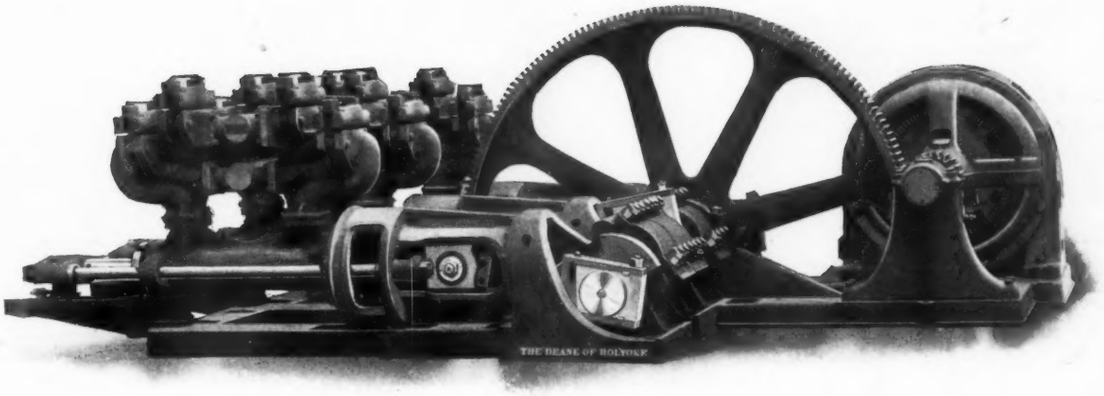
PUMPS



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Direct Connected or Belted
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The above illustration shows but one of many types. This one was designed for use in supplying water under 1000 pounds pressure to a number of hydraulic presses. Note its rugged simplicity, which is a typical feature of all pumps bearing the name

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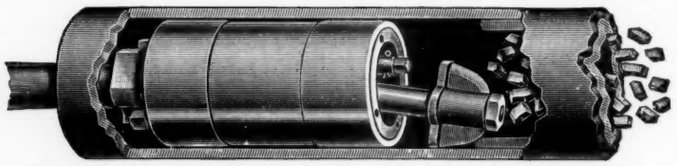
THERE are probably more devices and schemes for removing or preventing scale than for any other power plant purpose—yet boiler scale is still with us.



The Dean Removing Scale from the Tube of a Water Tube Boiler.

And coal is still wasted by the lining or covering of scale on boiler tubes—which is about as sure a non-conductor of heat as you can find.

This because the "scale preventers" don't prevent and the "removers" don't remove.

That is, they don't do the job thoroughly, if at all.

And it's for just this reason that the **Dean Boiler Tube Cleaner** appeals to practical engineers.

The Dean operates on a principle that compels thoroughness.

It will remove pound after pound of scale from boilers that have been "cleaned" by other processes or methods.

It enables the engineer to show tangible fuel savings and helps him to get recognition from the "old man" quicker than anything else.

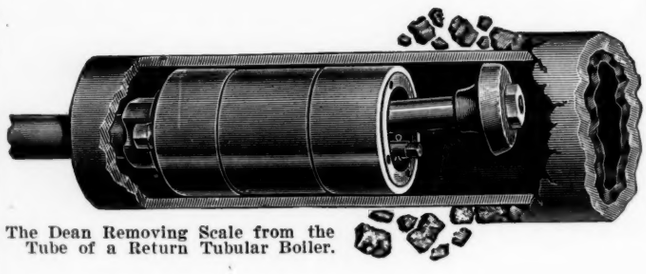
And any engineer can prove this to his own satisfaction at no cost whatever—we know the Dean, we know the scale proposition, we take all the risk.

We know it will pay any engineer to find the scale remover that really, thoroughly removes all the scale—

Therefore we know it will pay us to send you a Dean Cleaner with no strings attached to it.

The thing for every progressive engineer to do right now is to read and take up—

Our Trial Offer To Engineers



The Dean Removing Scale from the Tube of a Return Tubular Boiler.

Try the Dean in one boiler and if you don't like it, send it back at our expense.

If you like it, pay for it.

Then keep it six months and watch your coal pile.

If in that time the Dean hasn't paid for itself, send it back and we'll refund your money.

This is a bona fide offer to engineers—there are no strings to it. Write us today.

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POWER

Vol. 33 NEW YORK, JUNE 20, 1911 No. 25

THE engineer is prone to think that after he has once established an operating routine in his plant nothing special remains to be done in the way of increasing economy. That if he keeps his plant in good commercial shape and the bills run along about on an average it is evident the original economy is being maintained. Record keeping is irksome and as long as the plant expenses are about the same, month in and month out, he is satisfied.

But if he would dig deeper into his local conditions, know more about factors which surround him, he would probably find that there are circumstances in connection with his case of which advantage could be taken for obtaining an increase in efficiency.

Perhaps two engines are carrying the load when one will do the work more efficiently; an air leak in the setting may offset all efforts toward economical combustion; scale may coat the boilers sufficiently to prevent rapid transmission of heat, and there may be several other possibilities reducing the over-all efficiency of the plant—but why continue?

Record keeping will show up the fifty-seven varieties of little wastes, will absolve the furnaces from the sin of gluttony, and allow them to enjoy a normal, healthy, coal appetite—in fact, it will show how much money is being saved and what improvements or changes in the arrangement of the plant have been responsible.

It is in making a detailed study of the operating conditions that the greatest advantage of complete operating data is seen. Without them, if a change is made, how can it be known except in a general way what the effect has been?

Knowing things in a general way in this day and age does not get a man much in the engineering line. He must have specific information to show what he is doing and with records available, advantageous changes are frequently indicated which otherwise would remain in obscurity.

In other columns of this number is told the story of how a large saving was made by the simple expedient of shutting down the air compressor which controlled the thermostatic valves on the radiators of an office building.

This was not in a new plant where the routine was just being arranged, but in a plant which had operated for years at excellent economy and where a system of record keeping is in vogue that for completeness of detail probably cannot be surpassed in this country.

The saving realized here came about through the desire to take advantage of every opportunity for decreasing the coal bill.

Naturally, the light-load period is the time when energy costs most per kilowatt-hour and concentration of thought on the light-load period proved most productive, while with the operating records available it was possible to show just what the conditions were before, just what they were afterward, and just how much money could be placed on the credit side of the ledger.

This is a sample of the keen commercial instinct, the reducing of technical affairs to the dollar and cents standpoint, which mark the difference between the stopper and starter and the real engineer.

Pennsylvania Terminal Service Plant

By A. D. Blake

A plant of over 2500 boiler horsepower supplying the new Pennsylvania railroad terminal in New York city with light, power, compressed air, refrigeration and heat through an indirect system. During periods of no heating demand, electricity is taken from the Long Island power house.

One of the most important problems connected with the layout of the new Pennsylvania terminal station in New York City, was that of supplying service power, light, heat, etc.

The main power plant for the entire system is located at Long Island City, where the facilities for handling coal and the abundant supply of condensing water make it possible to generate electricity at a minimum cost.

While it would have been feasible to have supplied the passenger station with power and light from this source, there were other factors which had to be considered. Refrigeration was required in connection with the restaurant service; compressed air was necessary for the switching equipment and for the ejection of sewage; a high-pressure water system for fire protection was desirable; and most important of all, was the necessity of providing an adequate heating system.

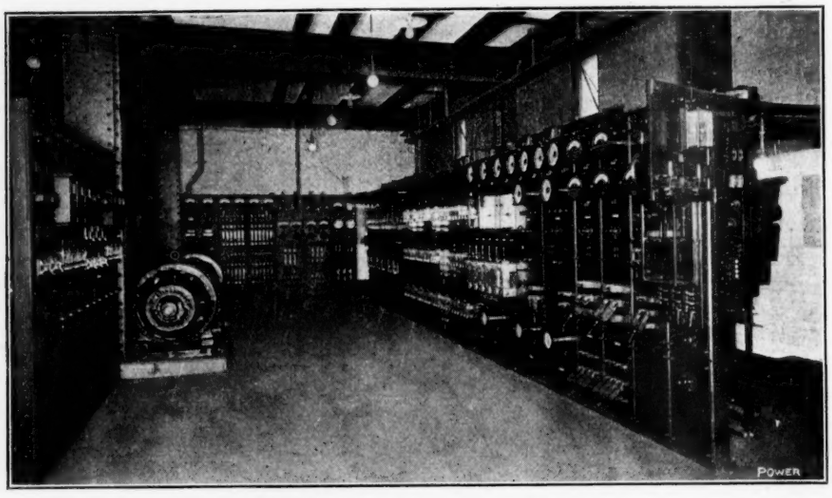


FIG. 1. SERVICE SWITCHBOARD, ALARM SWITCHBOARD AND EXCITERS

These, together with several other features, proved to be governing factors; hence it was decided to build and equip a service plant to meet the needs of the great terminal. The building also contains one of the railway substations supplying motive power to the trains.

According to the general scheme adopted, electricity for service light and power is generated during the winter months by noncondensing turbo-generators, the exhaust from which, together with that from the air compressors, pumps and other auxiliaries, is used for heating the station. During the summer months, however, when there is no heating demand, or at times when the exhaust from the compressors and pumps is sufficient to meet the demand, the turbines are shut down and electricity is taken from one of the 60-cycle machines at the Long Island power house. This arrangement also serves to guard against the terminal being without light and power should anything happen to the machines at either plant.

The service plant is located on Thirty-first street, opposite the station, with which it is connected by underground passages. The building is of steel and brick, faced at the front with granite to match the exterior of the station. It extends four floors above the street and three below. The street level is occupied by the boilers, the railway rotary converters and transformers and the various switchboards. The first level below the street contains the pump room and the direct-current switches; the second level the turbo-generators, air compressors, hydraulic-elevator pumps, ice machine and ash conveyer; and in the basement are located the sewage ejectors, ventilating fans for the service plant, part of the coal-handling apparatus, the storage battery and the refuse destructor. There is also an intermediate gallery containing part of the switch and bus structure.

FIG. 3. EXTERIOR VIEW OF SERVICE PLANT

The floors above the street level are occupied by the economizers, the coal-storage bin, offices and store rooms.

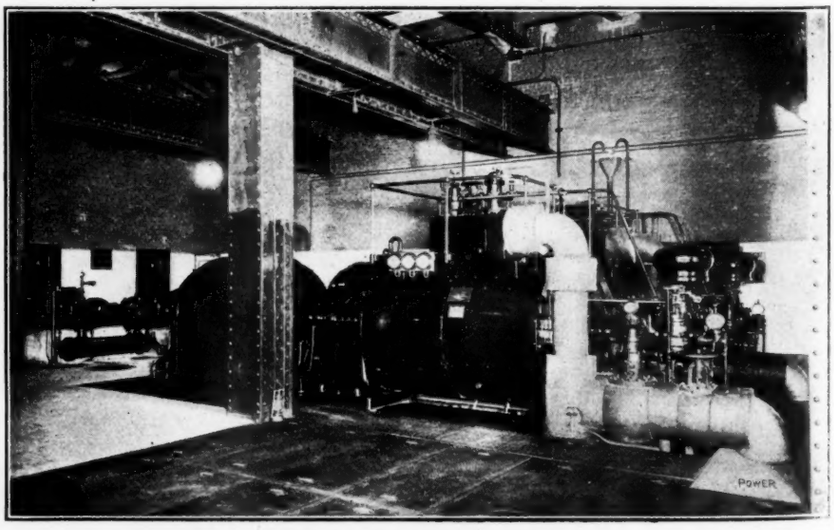


FIG. 2. TURBOGENERATORS

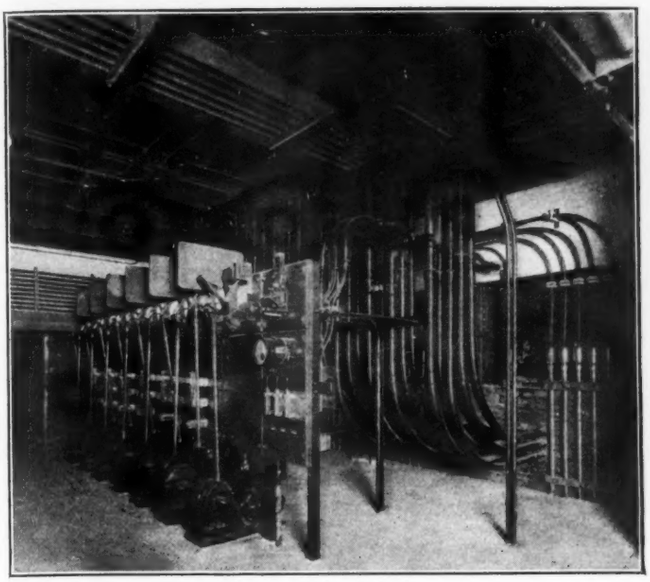


FIG. 4. DIRECT-CURRENT SWITCHBOARD

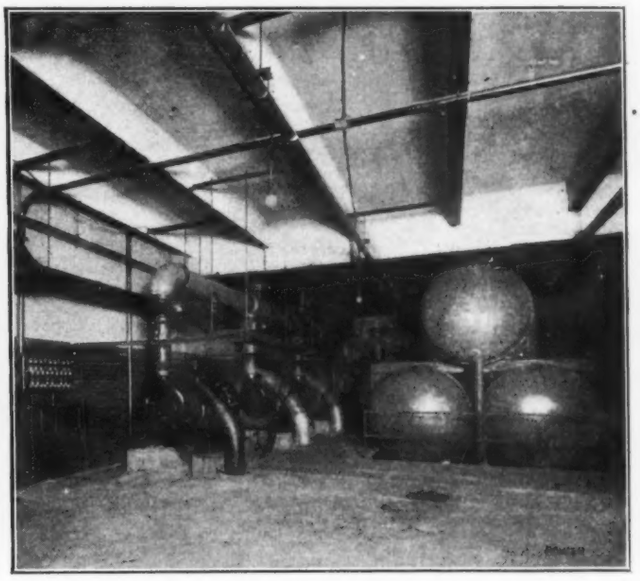


FIG. 5. MAIN HEATERS AND CIRCULATING PUMPS

BOILER PLANT

Steam is furnished by five 525-horsepower Babcock & Wilcox boilers equipped with shaking grates and designed to carry a steam pressure of 200 pounds, although they are usually run at about 160 pounds. Space is provided for five additional boilers of the same size to be installed as the demand for steam increases. Owing to the plant being in the heart of the city and therefore subject to the smoke ordinance, it was found inexpedient to burn bituminous coal; hence No. 1 buckwheat coal was selected and hand firing employed.

A radial-brick stack, carried on steel framing, rises 50 feet above the roof and the supports were made strong enough to carry an additional 50 feet of stack should the erection of adjoining buildings make this necessary. At present the top of the stack is 127 feet above the grates and the natural draft is supplemented with forced draft furnished

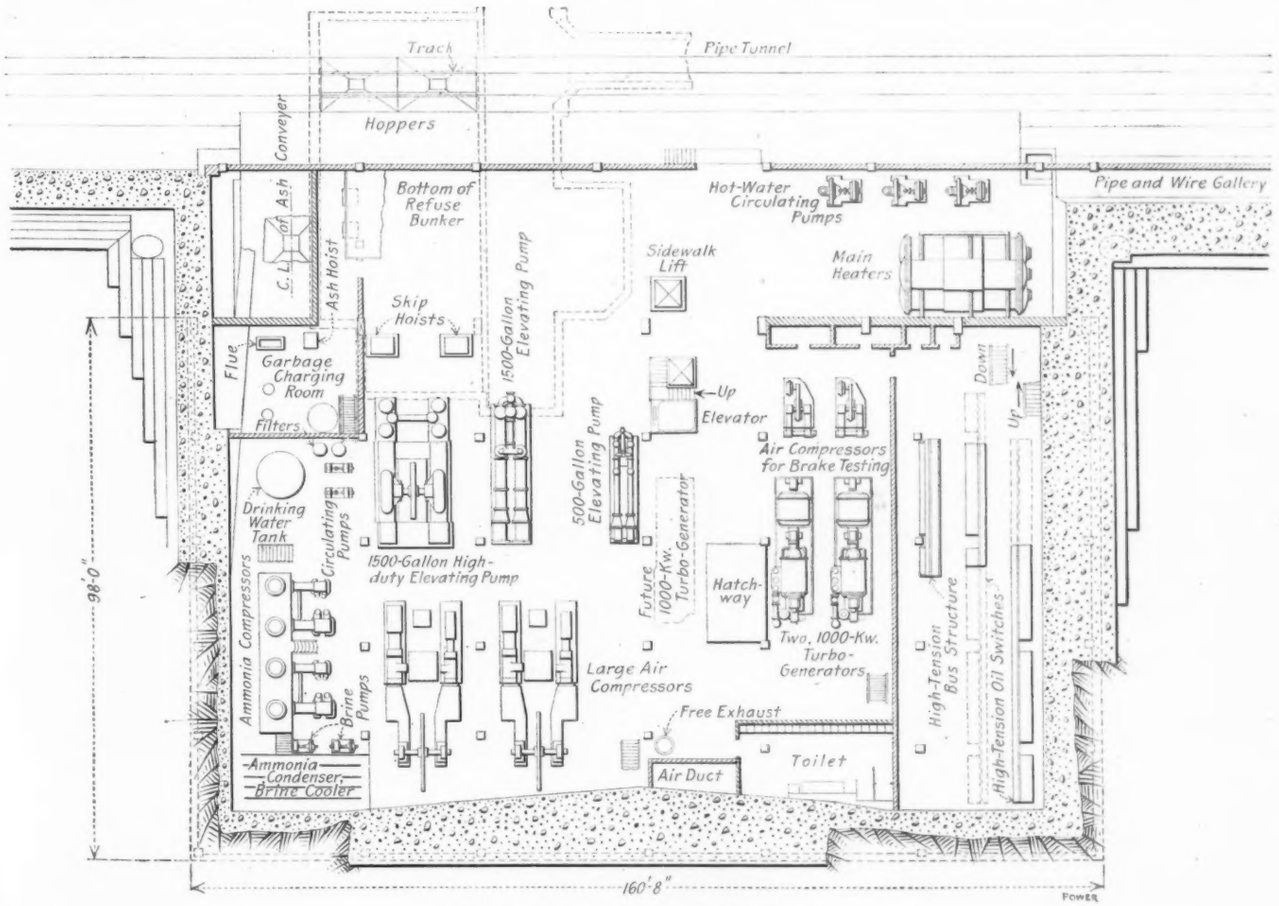


FIG. 6. PLAN OF ENGINE-ROOM LEVEL

by two Sirocco blowers direct connected to high-speed engines and capable of maintaining a pressure of 2½ inches of water in the ashpits.

The gases before reaching the stack pass through Green economizers, of which there are two, each containing 32 sections of 10 tubes.

The feed water is pumped from the hotwell to a feed-water storage tank of about 25,000 gallons capacity; from whence it is taken by the boiler-feed pumps and delivered to the feed-water heater, thence to the economizers where its temperature is raised to over 200 degrees Fahrenheit.

The heater is of the induction type and is located on a branch of the 18-inch line into which the auxiliaries exhaust.

The Holly system is employed to return the drips to the boilers.

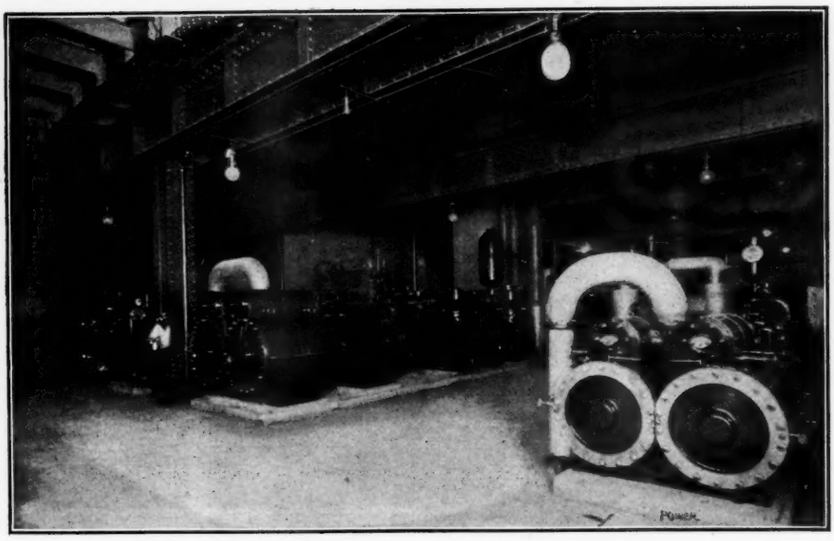


FIG. 7. HYDRAULIC ELEVATOR PUMPS

COAL AND ASH HANDLING

Coal is brought to the service plant in cars over the Pennsylvania railroad and dumped from the track level, which is one level above the basement, into a hopper from which it is carried by a belt conveyer to two skip hoists. These lift the coal to the top of the building and discharge onto a motor-driven belt conveyer which distributes it along a storage bin of 1000 tons capacity located over the boilers. From here the coal is delivered through hoppers and automatic weighing scales to the floor in front of the boilers. A significant feature of the coal-handling apparatus is that, from the

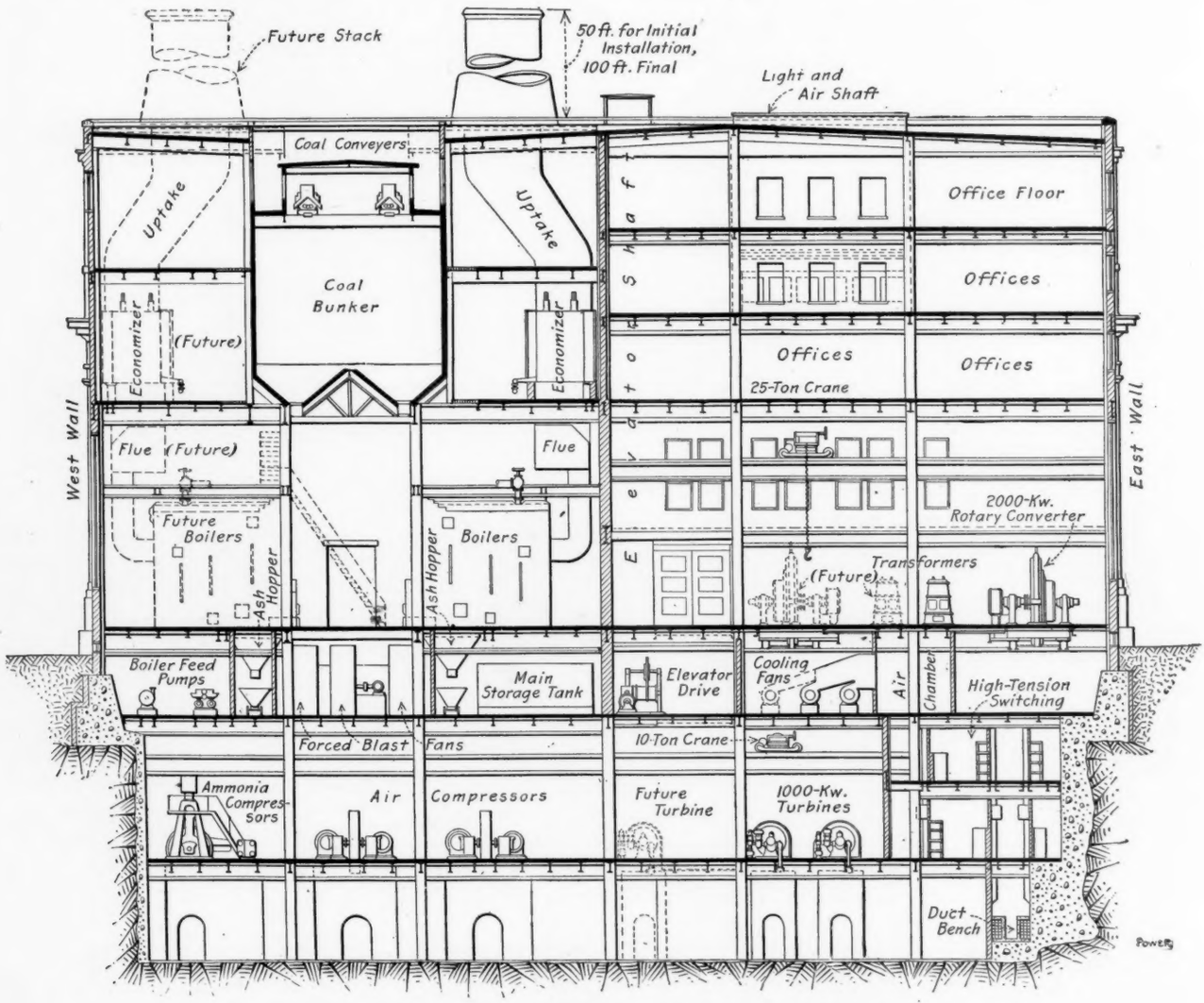


FIG. 8. SECTIONAL ELEVATION LOOKING TOWARD FRONT OF SERVICE PLANT

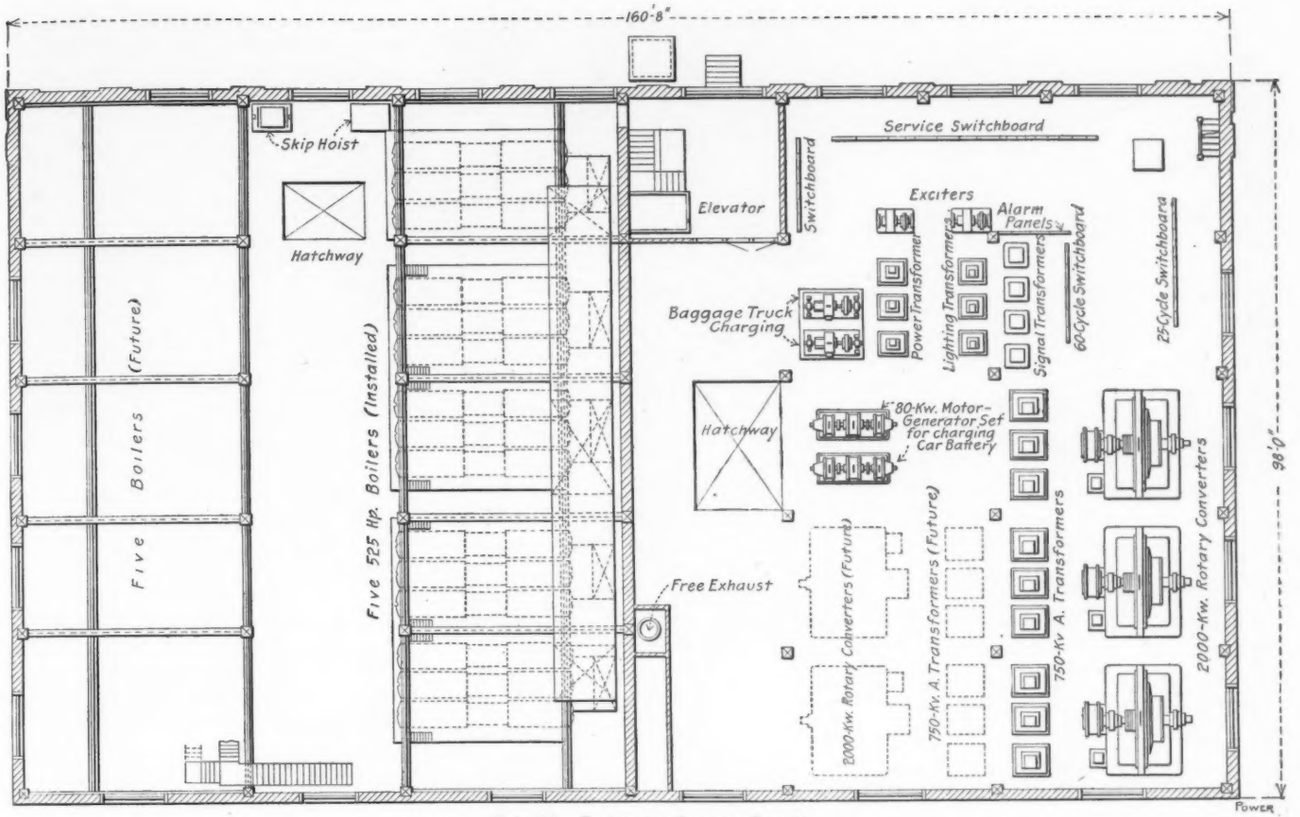


FIG. 11. PLAN OF STREET LEVEL

time the coal leaves the cars till it is in the bin, it is under the control of one man.

Under each ashpit there is a hopper through which the ashes are discharged into hand cars and wheeled out over a large reinforced-concrete storage hopper located under the sidewalk. This empties onto a belt conveyer which, in turn, discharges into gondola cars and the ashes are carried away over the same tracks upon which the coal is brought in.

LIGHT AND POWER

Electricity for light and power in the passenger station, as well as the service plant itself (when not supplied from the Long Island power house) is furnished by two 1000-kilowatt Westinghouse-Parsons turbo-generators running at 1800 revolutions per minute and generating three-phase currents at 240 volts. The leads from these generators are carried to solenoid-operated switches, thence direct to the 240-volt busbars on the service switchboard. These connect with the lighting panels of the switchboard from which three-conductor cables lead to a number of subswitchboards located in various sections of the terminal. These, in turn, supply numerous panel boards from which the circuits are so arranged as to balance the load between the three phases. With the exception of a few tungsten lamps in the main waiting room and office hallways, the light is furnished by Nernst lamps. As a matter of general interest, it may be stated that there are over 100 miles of electrical conduit in the passenger station alone.

Power for the various motor circuits is at 420 volts. This is supplied through two banks of transformers (see Fig. 13). The circuit leads from the 240-volt busbars to one of the transformer panels, through a disconnecting switch to the primary side of one bank of transformers where the voltage is stepped up to 11,-

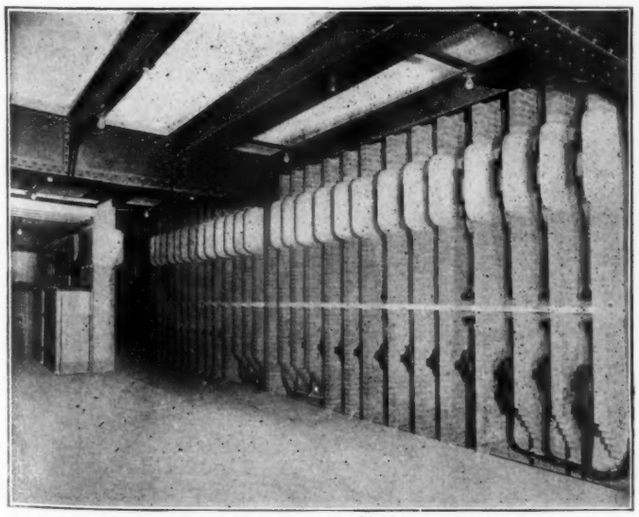


FIG. 9. BARRIERS OF HIGH-TENSION SWITCH STRUCTURE

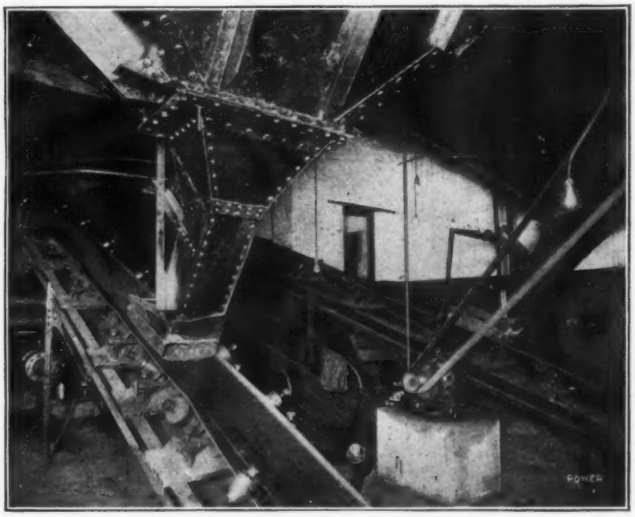


FIG. 10. COAL CONVEYER

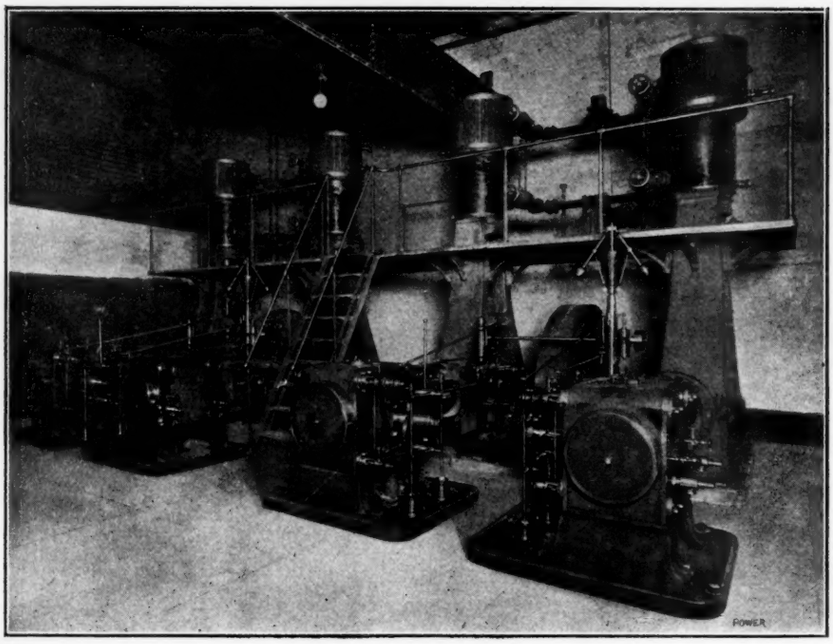


FIG. 12. REFRIGERATING MACHINES

000. It then passes over to the other bank of transformers where it is stepped down to 420 volts, and from here passes through another disconnecting switch to the 420-volt busbars; these supply the power circuits.

Although this arrangement may at first seem cumbersome, its flexibility becomes apparent when it is considered that during part of the year current is taken from the Long Island power house. This is brought over at 11,000 volts and after passing through the high-tension switching structure, the circuit ties in between the two banks of transformers; here it divides, part being stepped down to 240 volts for lighting and the remainder to 420 volts for power.

There are two motor-generator sets for furnishing excitation to the generators. A 60-cell 400-ampere-hour storage battery supplies excitation when starting the turbo-generators and also supplies emergency lighting circuits around the plant as well as the fire-alarm circuits.

Direct current for charging the motor-driven baggage trucks and automobiles is supplied by two motor-generator sets. The electric elevators and dumbwaiters are operated with direct current at 650 volts, taken from the rotary converters supplying the train motive power.

AIR COMPRESSORS

There are three principal uses for compressed air about the terminal: the electropneumatic switching and signal system, sewage ejection and brake testing. Compressed air for the first two services is supplied by two cross-compound, two-stage Nordberg compressors, each having a capacity of 2000 cubic feet of free air per minute and compressing up to 90 pounds per square inch. There is an intercooler between the air cylinders and an atmospheric aftercooler located on the roof.

For testing the brakes on cars, however, a higher pressure is required and for this purpose two motor-driven compressors are provided. These have a capacity of 100 cubic feet of free air per minute and compress to 125 pounds per square inch. Their operation is entirely automatic;

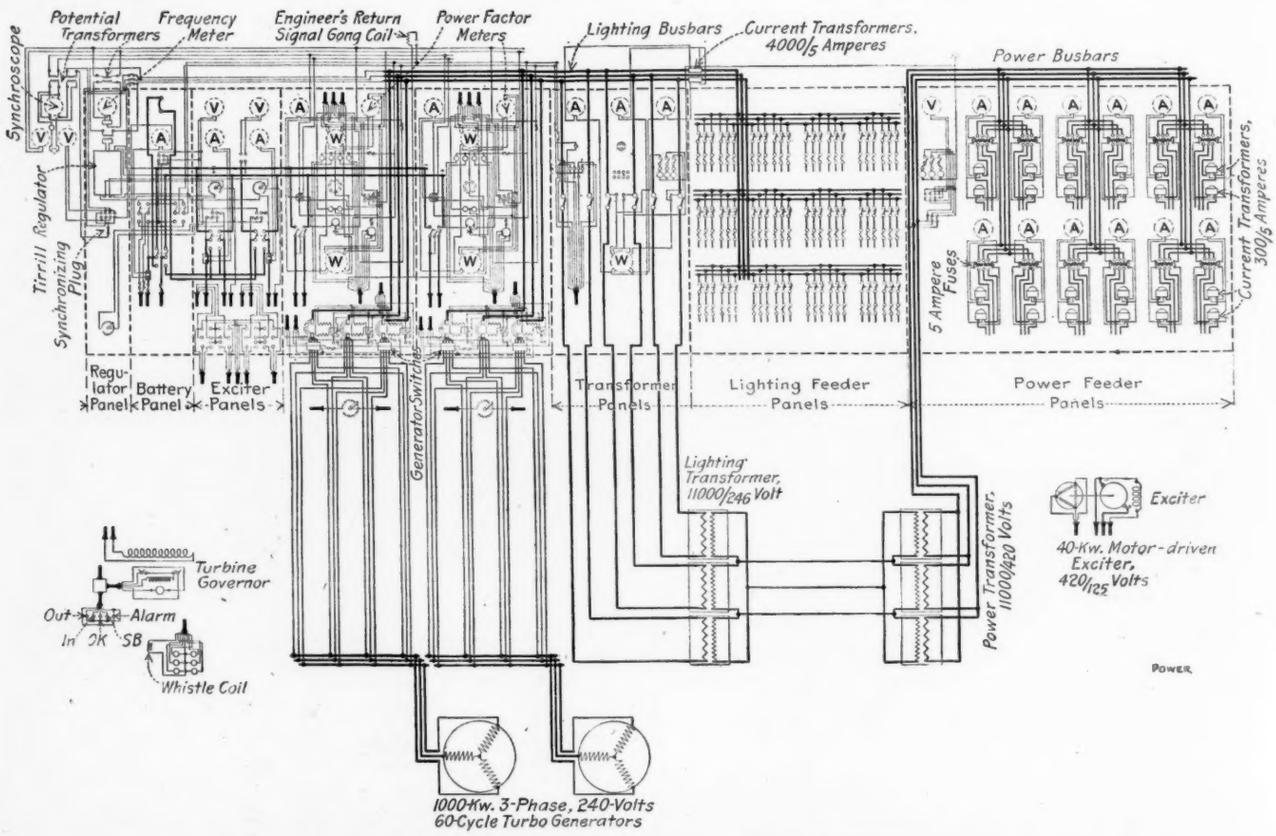


FIG. 13. WIRING DIAGRAM OF SERVICE SWITCHBOARD

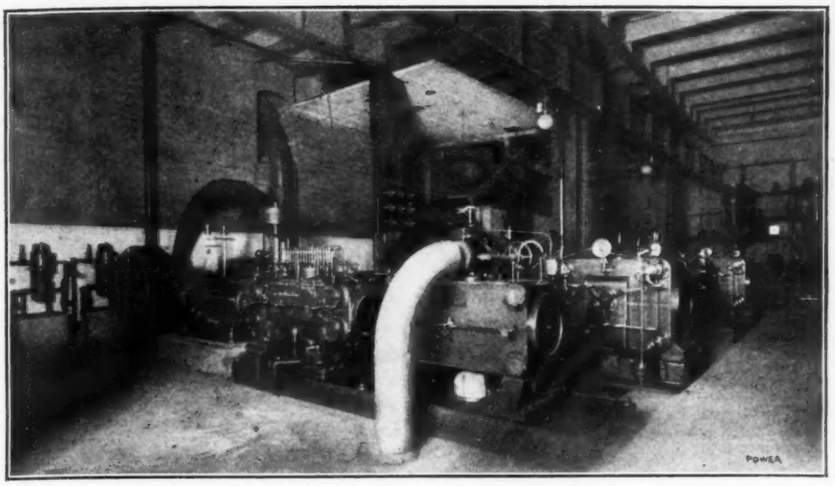


FIG. 14. MAIN AIR COMPRESSORS

If this compressor is unable to supply enough air to maintain the required pressure, the other is automatically started and continues until the upper limit of pressure is reached.

Air for the hydraulic elevator tanks is taken from the Nordberg compressors at 90 pounds and stepped up to 300 pounds by two railway air-brake compressors mounted on the wall just behind the large compressors.

HYDRAULIC ELEVATOR SERVICE

All the baggage lifts, twenty-one in number, and eleven of the passenger elevators are of the direct-acting plunger type, working at a water pressure of 300 pounds per square inch. These are supplied by three compound steam pumps, one a Heisler high-duty flywheel pumping engine having a capacity of 1500 gallons per minute; the second is a direct-acting pump of 1500 gallons capacity, and the third is of similar design but having a capacity of only 500 gallons per minute. The maximum load can be handled by operating one of the large pumps in connection with the small one. A 3000-gallon pressure tank, a 3000-gallon suction tank and a 5000-gallon surge tank form part of the hydraulic-elevator system.

REFRIGERATING SYSTEM

The refrigerating plant consists of two 40-ton vertical single-acting York ammonia compressors, each having two ammonia cylinders and direct connected to a horizontal cross-compound Corliss engine. Calcium brine is circulated by centrifugal pumps through the cooling boxes in the kitchens of the station. The temperatures required in these boxes vary from 10 to 28 degrees Fahrenheit according to their contents.

Drinking water for the station is filtered and cooled in the service plant, before being circulated through the system.

HEATING SYSTEM

The station is heated by an indirect system. The exhaust steam from the compressor engines, elevator pumps, fire pumps, etc., is delivered through an 18-inch main to three closed tubular heaters having a total heating surface of about 17,500 square feet. A 30-inch exhaust-steam main also leads from the turbines to the heaters and provision is made for using live steam when the supply of exhaust steam is inadequate. The condensed steam from the heaters flows to the hotwell.

The heating water after passing through the heaters is circulated by motor-driven centrifugal pumps through a closed system of heating coils, in the passenger station, over which fresh air is drawn by fans and circulated through the various rooms. The heating is regulated by varying the supply of steam to the main heaters, and any temperature of water up to 200 degrees may be obtained. The maximum air temperature obtainable is about 130 degrees.

In addition to the station heating considerable live steam is required for heating the switch cabins and the cars while they are in the station yard.

The total steam required during the month of March, 1911, was over twenty million pounds.

Every room in the terminal is ventilated by mechanically exhausting the air from it, there being in all 21 ventilating fans.

WATER SUPPLY

Water for fire protection is furnished by two steam-driven pumps, each having a capacity of 1500 gallons per minute. They are automatically controlled, taking water from the city mains and discharging at 150 pounds pressure. In order that they shall at all times be ready for service, they are kept running continually at a slow rate, a small quantity of water being utilized for other purposes from the fire mains.

The water used in the kitchens of the restaurant is taken direct from the city mains while that supplying the drinking fountains throughout the station is first filtered and cooled in the service plant and then forced through the system by motor-driven centrifugal pumps. Water from the cooling jackets and coils of the air compressors and the refrigerating system is used for flushing the toilets.

A storage tank of 50,000 gallons capacity in the service plant is kept constantly filled to furnish an emergency supply, should the city supply fail.

All sewage is led to ejector tanks located in the basement and in the pipe tunnels; these are automatically emptied by means of compressed air into the street sewers.

All drainage in the service plant below the sewer level and the drips are led to a sump in the basement. This is periodically emptied by automatic float-controlled motor-driven pumps. Similar

FIG. 15. ROTARY CONVERTERS AND TRANSFORMERS

sumps are located in the pipe tunnels under the station and yard.

Substation

The substation, which is located in the service-plant building, furnishes motive power to that section of the electrified system which is within the vicinity of the terminal. Twenty-five-cycle, three-phase currents at 11,000 volts are generated at the Long Island power house; these are stepped down at the substation, converted to direct current at 650 volts and delivered to the third rail. Sixty-cycle, three-phase currents at 11,000 volts are also supplied and are stepped down to 420 and 240 volts for (alternative) service power and lighting and to 2300 volts for the primary circuit of the signal system. The substation equipment consists of nine single-phase 750-kilovolt-ampere air-cooled transformers, delta connected and supplying three 2000-kilowatt rotary converters. The latter are started by induction motors mounted on the same shaft with the rotor. These starting motors are supplied with power through a set of three transformers connected to the 11,000-volt line.

There are also three 11,000-2300-volt transformers which supply current for the train-signal system.

The high-tension switch and bus structure is of selected buff brick with soapstone barriers and cement slabs. All the oil switches are solenoid operated and are controlled from two switchboards on the main floor. There are two sets of bus-bars and the arrangement of switches is such that any feeder or section may be cut out for repairs without interfering with the rest of the equipment or interrupting the service.

The direct-current switches for the train feeders are all motor-operated and are located on the floor below the converters, although they are controlled from the same switchboard as are the high-tension oil switches.

In all, there are five switchboards, but these are arranged so that one operator can attend to them all.

At present the load is such that only two rotary converters are required to be in service at a time, the third being used as a spare; but space has been provided for three additional machines.

The entire plant was designed, built and equipped by Westinghouse, Church, Kerr & Co., of New York.

Analysis of Industrial Power Costs

By M. Oswald Jenkins *

The items chargeable to the cost of producing power in an isolated plant from the central-station viewpoint.

*New York Edison Company.

The cost of producing a unit quantity of power from small steam plants, such as are usually found in city manufacturing buildings, ranging from 100 to 400 horsepower in capacity, presents a subject which, although by no means new, is ever interesting owing principally to the widely varying results which may be obtained for a given case, depending largely upon the object for which the calculation is being made, and also upon the skill of the investigator.

If the unit cost of producing a given quantity of power is being sought for the purpose of making a direct comparison with the cost of purchasing the same amount of power, as a finished product, from an outside source, such as a central station, the character of the investigation and the cost items concerned would be quite different than if comparison were being made with similar power-producing plants.

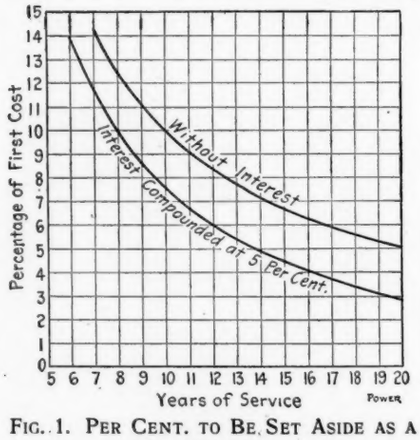


Fig. 1. Per Cent. to Be Set Aside as a Sinking Fund

Operating and designing engineers associated with power-plant work in general, and those identified with the smaller plants in particular, are interested in the efficiency of operation, and consequently in the cost of operating a power plant only as affected by its inherent efficiency, which includes only the actual cost of operation, such as fuel, labor, water and repairs. These constitute what might be termed factory costs as distinguished from total-production costs and the selling price of the manufactured article. They are quite sufficient for purposes of comparison with similar plants, revealing as they do the exact and complete results from the viewpoint of economy in design and operation. They are also sufficient for determining the selling price of power where the purchaser is a tenant in the building and as such is obliged to pay his *pro rata* share of the plant investment and other fixed expenses in the form of rent, irrespective of the power requirements.

Such an indirect power charge is usually of necessity in proportion to the floor space occupied by the purchaser, rather than in proportion to the demand on the power plant; the latter being a more just method of fixing the price. Thus, the cost of power as expressed in terms of cents per horsepower-hour or kilowatt-hour, or dollars per horsepower per year, and considered to be the total cost of producing power, may represent only that portion of the total cost known as operating expenses of the plant, and may be misleading. The total power cost includes other items of expense to which particular attention is herein directed.

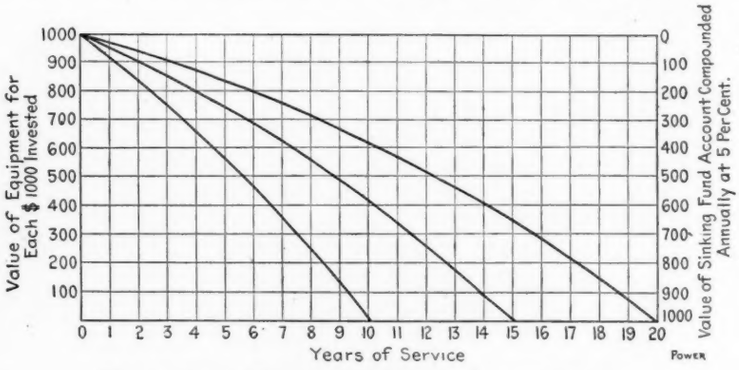

Value of Equipment for Each $ 1000 Invested
Value of Sinking Fund Account Compounded Annually at 5 Per Cent.
Years of Service
POWER

Fig. 2. Chart Showing Present Value of Plant

Since the general introduction of electric power from a public supply for manufacturing purposes, comparison between the cost of purchasing electric power delivered to the premises, and of producing power by a steam plant on the premises, requires a more comprehensive view of the plant costs and a better understanding of a correct and proper method of

determining them; failure to do so often leads to erroneous conclusions, with results likely to be unfair to both producer and consumer of the public supply.

The power-costs account should rightly include every item pertaining to the plant presence and operation. Both items and accounts are to be determined on the basis that the power-plant operation is an entirely independent business than that primarily engaged in by the owner, and as such is to be dealt with accordingly. As any essential department of a well organized business (which a power plant is not if public power is available) must be able to stand on its own account, so should a power plant, and even more so, for it must provide adequately for power requirements for the entire factory, including any and all emergencies. It must continue to do efficient service for as many years as the factory will require, and above all must show a return on the capital invested in it equal to that of the average manufacturing business, where money invested is not free from risk, say, 15 per cent. over and above all other items of expense.

In order to arrive properly at the various costs generally known as fixed charges on a plant, some method of accounting must be employed. In every case where money is invested in manufacturing a commodity which is incidental to the general business, and which may be purchased from a public supply, the important thing is to be able to quickly determine the ability or inability of the manufacturing costs to compete with the cost of the public supply, and the method of accounting that will best show which is the one to employ. The principle is to buy whatever can be purchased cheaper than it can be manufactured, it being presumed that those who make a specialty are better equipped to turn it out cheaply than one would be who turns it out simply as a byproduct.

The original cost of a power plant may be represented by two accounts at all times; namely, the present value, and the value of the sinking-fund reserve established for depreciation. The sum of these two accounts should at all times be equal to the original investment. Each of these may again be divided as in the following schedule. The amount indicating the plant value would consist of two items, the salvage or market value, and that chargeable to obsolescence, the latter being the difference between the present and the salvage values:

- Original cost
  - Depreciation and amortization sinking fund.
    - Interest compounded.
    - Portion of plant earnings.
  - Present value...
    - Salvage value.
    - Loss owing to obsolescence.

The original capital investment of successful operations must be returned from the earnings. This may be accomplished by means of a sinking-fund reserve, established solely for amortization, in which case depreciation is taken care of separately, or both depreciation and amortization may be represented by a single sinking-fund reserve. For small plants the depreciation account for obvious reasons usually serves both purposes and will be so considered here. The process consists of setting aside a certain percentage of the earnings each year to be invested in a safe security which at compound interest will equal the original investment in a given number of years according to the life of the plant.

Fig. 1 shows the amount in per cent. of the original investment to be set aside each year as a sinking fund in order to return the principal in from 5 to 20 years, according to the life of the plant. The upper curve provides for a return without interest and the lower one with interest compounded annually at 5 per cent. The account thus established is wholly for depreciation and amortization and is not intended to provide for maintenance or repairs, which come under operating expenses, or for additions or renewals which are capital charges and should be treated as original costs.

In connection with this it may be well to remember that the life of a power plant is not determined solely by its physical ability to operate satisfactorily. Circumstances bearing on business growth, location, management and cost of power from a public supply may render it useless long before old age makes itself felt. It is the general experience that from 12 to 17 years constitute the life of the average plant and many have been abandoned at a much earlier age.

From the curves in Fig. 2 can be determined the present plant value for a useful life of 10, 15 and 20 years. These curves show that a $10,000 plant estimated to have a useful life of 15 years will be worth a trifle over $4000 after 10 years' operation. Any number of curves

TABLE 1. STEAM-POWER COST REPORT

INCLUDING LIGHTING AND HEATING FOR PLANT OF

Name..... Address.....

Industry..... Plant in operation..... Years useful life.....

POWER-PLANT EQUIPMENT	First Cost			
Boilers, engines, pumps, piping and foundations				
Dynamo, switchboard and wiring				
Belting and shafting				
Motors and wiring				
Total for complete plant				
Present plant value, based on ..... years of useful life				
Amount credited to sinking-fund account				
Salvage value of entire plant				
Obsolescence chargeable to new investment				

ANNUAL COST OF STEAM POWER

	Items Chargeable to Investments Account	Cost			
1	Interest on investment of $.....@....per cent.				
2	Depreciation of equipment, value $..... Useful life..... years.....@....per cent.				
3	Taxes on value of plant.....@....per cent.				
4	Insurance, owing to operation of plant.....@....per cent.				
5	Value of space ..... square feet @ $ ..... per square foot ...				
6	Superintendence and profit on investment, over and above heating plant cost of $.....@....per cent.				
	Items Chargeable to Operating Expenses				
7	Engineer @.....$.....per month				
8	Fireman @.....$.....per month				
	Fireman @.....$.....per month				
	Fireman @.....$.....per month				
9	Coal tons @.....$.....per ton				
10	Water for boiler, cubic feet @.....$.....per 100 cubic feet				
11	Removal of ashes, months @.....$.....per month				
12	Oil, waste and packing				
13	Cleaning boiler				
14	Repairing and maintaining all steam apparatus				
15	Repairing and maintaining all shafting and belting				
16	Repairing and maintaining all motors				
17	Loss of time attending shut-down for repairs				
18	Overtime for engineers and firemen				
19	Lamp renewals				
20	Loss of output due to speed variation				
21					
	Auxiliary Purchased Power				
22	Electric power for factory				
23	Electric power for elevators				
24	Electric power for other purposes				
25	Electric power for lighting				
26	Electric power for break-down service				
27	Gas for lighting				
28	Gas for heating				
	Total cost for all light, heat and power				

might be constructed in a similar way corresponding to different lengths of plant life. Having in this manner fixed the present value, other values may readily be determined when the question of abandoning the plant is being considered. If, as cited, after 10 years' operation the plant were to be abandoned, the new power account should assume responsibility for the difference between $4000 and the salvage obtainable. In other words, the amount due to obsolescence would be chargeable to the new power account as an investment charge, when by the operation of a new sinking-fund reserve it will be returned as original capital. In fact, it could not be otherwise, for, partly due to the ability of the new account to carry the obsolescence charge, it proves its claim to the right to replace or supersede an existing plant. In the many cases where large power companies replace comparatively new machinery with larger, more efficient and more expensive machinery, and where large, beautiful buildings are being replaced with larger and more modern ones, a like method of determining the amount chargeable to obsolescence is employed with good effect.

Table 1 will serve to show the items of expense involved in operating a plant, and is arranged for the purpose of showing the exact average yearly cost at any time during the life of the plant. The average yearly cost is important to consider, and it is absurd for one to say that the plant has paid for itself, and now costs nothing except the operating expenses of labor, coal, water and repairs. The fact is that the former yearly average cost may have been slightly reduced or increased by reason of continuous operation, but could never be reduced to nothing even if the plant were to operate indefinitely.

There is perhaps little need of calling special attention to all of the items appearing under the heading of "Annual Cost of Steam Power" since each appears to be a proper charge. However, items Nos. 6 and 22 may require further consideration. Item 6 provides for, first, the time and thought given to the plant affairs by the head of the establishment and the superintendent of the factory, who must assume the responsibility of keeping all things going, directing the buying of coal, lamps, oil and supplies, engaging engineers and firemen, and seeing that repairs are made; second, a power plant is not an essential part of the business but an independent business and should be able to show a profit on the money invested in it over and above bare interest. The profit to be expected should be at least equal to the profit of the principal business engaged in; otherwise the owner would be much better off if the plant investment were in the form of a safe security paying only 5 per cent. and the factory were purchasing power from the public supply.

Item 22 refers to the loss of output due to a variation of speed at the driven machines, thereby affecting the output. It is plain to be seen that if the average speed of a productive machine were 5 per cent. below the maximum, due to such variation, the output would suffer; or, in other words, by the use of purchased power—presuming that its amount would be constant—nearly 5 per cent. increased output could be obtained with the same factory equipment and labor.

Table 2 shows an electric-power cost form corresponding to the steam-power form. As inspection will show, it provides for every item of expense likely to be incurred for light, heat and power supply.

It is believed that such a method of accounting for power costs will produce results which are fair to all parties concerned.

TABLE 2. ELECTRIC-POWER COST REPORT

INCLUDING LIGHTING AND HEATING. FOR FACTORY OF.....

Name..... Address.....

Industry..... Per cent. of individual drive.....

Motor Equipment	First Cost			
No. of motors.... Average horsepower.... Total horsepower.....				
Wiring.....				
Belting and shafting.....				
Total for complete installation.....				
Obsolescence charge on old steam plant to be carried.....				
Total amount as investment charge.....				

Annual Cost for Electric Power Item Chargeable to Investment Account	Cost			
1 Interest on investment of $.....@.....per cent.				
2 Depreciation on equipment value $..... Life .....years.....@.....per cent.				
3 Taxes, owing to increased valuation.....@.....per cent.				
4 Insurance due to motor equipment.....				
Items Chargeable to Operating Expenses				
5 Electrical energy for factory...kilowatt-hours @....per kilowatt-hour.....				
6 Electrical energy for lighting...kilowatt-hours @....per kilowatt-hour.....				
7 Lamp renewals.....				
9 Gas for lighting.....				
10 Repairing and maintaining motors, shafting and belting.....				
Items Chargeable to Steam Heating				
Required to provide annually ..... pounds of steam for building heating and ..... pounds for manufacturing purposes.....				
Value of old or new boilers for heating $.....				
11 Interest and depreciation on boilers @ ..... per cent.....				
12 Coal.....tons @.....per ton.....				
13 Labor.....months @.....per month.....				
14 Water.....cubic feet @.....per cubic foot.....				
15 Removal of ashes.....months @.....per month.....				
16 Repairing and maintaining boilers and heating apparatus.....				
17 Gas for heating.....				
Total cost for all light, heat and power.....				

Compression

Steam is let into the cylinder of a steam engine for the sole purpose of turning the crank shaft at a predetermined speed against resistance. When the legitimate resistance is augmented by avoidable friction the possible efficiency of the machine is not reached.

To turn the shaft, pressure is applied to one side of the crank pin and whatever reduces the pressure upon this side of the pin or adds to that upon the other reduces the total output of energy at the flywheel and decreases the efficiency of the engine.

Compression of steam on one side of the piston reduces the effective pressure of the steam on the other side and decreases to this extent the pressure available for turning the crank shaft of the engine.

When the pressure of compression exceeds the pressure of the expanding steam the energy required for the work must be taken from the flywheel, reducing the amount of energy available for useful work.

Compression reduces the area of the indicator diagram, showing that for any given point of cutoff less work will be done in the cylinder when compression is used.

Though compression fills the clearance space with steam taken from the exhaust pipe instead of from the boiler, it takes steam from the boiler to run the engine to do the compressing, and if there is no other loss the friction of the engine during the period of compression is the price that must be paid.

Flexible Operation with Oil Fuel*

By Herbert A. Wagner

At the Westport station of the Consolidated Gas, Electric Light and Power Company of Baltimore, oil fuel is used for banking and in conjunction with coal for handling peak loads. With this arrangement the boilers have been forced to four times their rated capacity.

*Abstract of a paper read before the National Electric Light Association at New York City, June 2, 1911.

It is well known that the capacity of the modern water-tube boiler depends, within fairly wide limits, upon the amount of fuel burned per hour. Several plans have been proposed and used to increase the grate area so that more fuel can be burned, but the only practical plan for doing this necessitates firing from both ends; this requires increased space and additional devices for coal handling, etc.

The load on the Westport station of the Consolidated Gas, Electric Light and Power Company of Baltimore has well defined peaks of comparatively short duration, and these considerations led to experiments with fuel oil for supplementing the coal fires and obtaining the desired increase in boiler output.

After trying several settings the furnace arrangement shown in Fig. 1 was finally adopted, and proved so satisfactory that it was decided to equip the entire boiler plant in this way. The boilers are of the standard Babcock & Wilcox type and are rated at 650 horsepower. The space back of the usual coal grate is made into a large combustion chamber with the oil burners at the extreme rear end. This combustion chamber is separated from the boiler tubes above it by tiling and from the coal grate by a low bridgewall. The hot gases from the burning oil pass over the coal grate and upward through the first pass in the usual three-pass Babcock & Wilcox setting. Ample air inlets are provided around the burners and also in the side of the combustion chamber. Each furnace is provided with four oil burners.

The oil is delivered to the burners under 20 pounds pressure and is atomized in each burner by a steam jet, the steam required for this purpose being less than 1 per cent. of the amount generated by the boiler. By this arrangement either oil or coal or both together may be used to fire the boiler. Furthermore, the changes from the ordinary boiler setting are very slight and require no additional space. One of the four burners in each furnace is used as a pilot and for the equivalent of a banked coal fire for keeping the boiler ready to steam. These pilot or banking burners are operated from a separate oil line, so that a single valve in the main oil line may be used to turn oil into any number of furnaces desired, thus putting any number of banked boilers into commission instantly. The general arrangement of piping is shown diagrammatically in Fig. 2. The master valves 1 and 2 each control the pilot or banking burners for a group of five boilers, and in like manner the valves 3 and 4 control the remaining burners in each group. For illustration, assume that group *A* is being fired with coal for the usual load, and that group *B* is banked with oil; valves 1, 3 and 4 will then be closed and valve 2 will be open. If a sudden increase of load occurs the opening of valve 4 upon signal from the switchboard will instantly put group *B* into service. Still greater capacity could be obtained by opening the valves 3 and 1, to operate boilers *A* with both coal and oil. In addition to the master valves shown, there are, of course, valves for controlling each burner and the group of burners for each boiler.

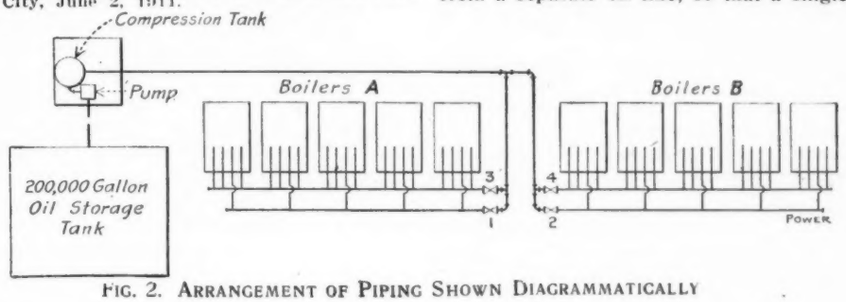


FIG. 2. ARRANGEMENT OF PIPING SHOWN DIAGRAMMATICALLY

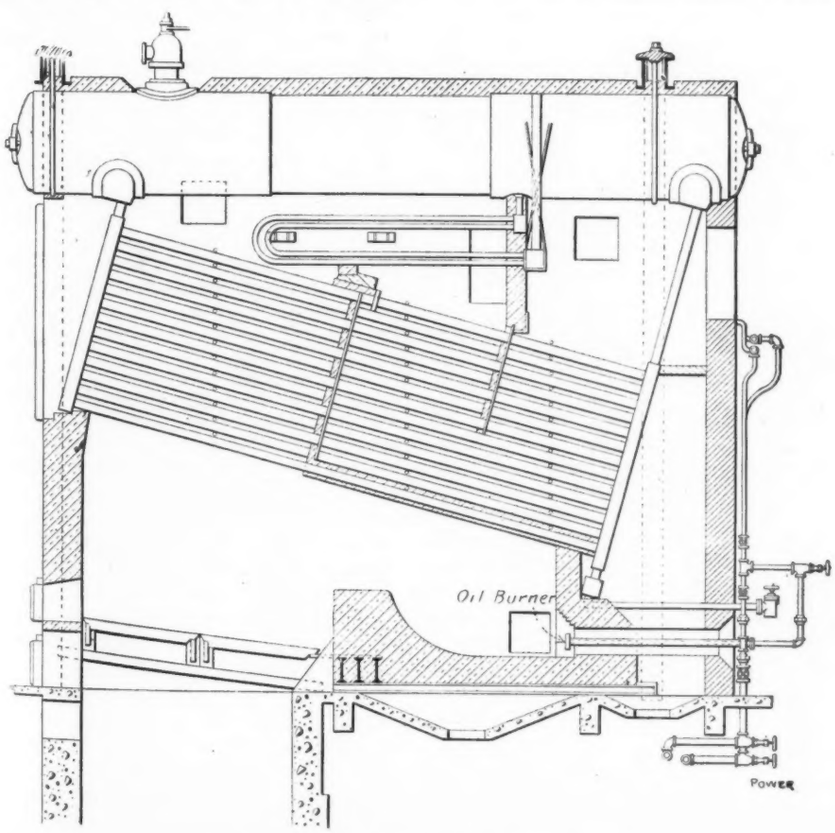


FIG. 1. FURNACE DESIGN FINALLY ADOPTED

Ordinary boiler tests with this arrangement have shown approximately the following results for maximum boiler output during seven-hour runs:

Coal alone	1188 horsepower
Oil alone	702 horsepower
Coal and oil together	1445 horsepower
Coal and oil maximum, one hour	1632 horsepower

Under actual operating conditions, however, the gain by the use of oil is

more marked. It has been found that 2000 kilowatts of station load can be carried by each boiler when using coal and oil together, with as much ease and certainty as 1200 kilowatts per boiler can be carried by coal alone. This shows, under operating conditions, a gain in capacity of 66⅔ per cent. by the use of oil, or a saving of 40 per cent. in the cost of the boiler plant for a given capacity.

It is under emergency or peak-load condition, however, that the advantages of fuel oil must be considered, and the durations of load under such conditions are usually too short for any comparisons by the usual boiler-test methods. Tests were made, therefore, under regular operating conditions to determine the minimum number of boilers which could be used to carry actual peak loads. The best record obtained in past operation at the Westport station with coal was 16,888 kilowatts carried on eleven boilers; this is equivalent to 1535 kilowatts per boiler.

The same station operating in conjunction with a hydroelectric-power transmission line recently carried a load of 11,100 kilowatts for two hours with four boilers fired with coal and oil. This represents a load of 2775 kilowatts per boiler of 650 horsepower rating.

Tests have shown that a cold furnace, with water in the boiler at 142 degrees Fahrenheit, could be made to steam at 175 pounds pressure in 25 minutes with oil fuel as compared with 42 minutes with coal.

The cost of fuel oil at Baltimore is 43 per cent. more than coal, per heat unit, but in spite of this difference the actual cost of "banking" is less with oil than with coal, for the reason that the oil is burned efficiently while the coal is necessarily burned very inefficiently.

Fuel oil shows its advantages as compared with coal most markedly when used as fuel for operating steam plants in connection with long power-transmission lines from water-power plants. Owing to conditions which, up to the present time, are inseparable from high-tension transmission lines, steam auxiliary or standby plants are a necessary adjunct to such lines where power is used to supply the various needs of a large community. Such steam plants may be required merely to supply power during brief interruptions due to transmission-line troubles, or to supply part of the power for peak loads, or to make up for deficiencies in the water flow during dry seasons.

In Baltimore the local company purchases at present about 15,000 kilowatts from the Pennsylvania Water and Power Company. This is transmitted over 40 miles of transmission line at a pressure of 70,000 volts. The local company generates by steam all power for peaks over the 15,000 kilowatts purchased. The steam plant is operated in parallel with the water-power plant, and normally carries a constant load of about 2000 kilowatts, and as much over that amount as peaks may demand. In addition to this the steam plant stands prepared at all times to take the entire load should the transmission-line power fail.

So far during six months of operation there have been few interruptions on the transmission line. With but one exception these have been due to the failure of relays to operate properly. Such failures as have occurred, however, have thoroughly tested the value of fuel oil for quick steam generation. A few of these severe tests will be mentioned.

December 4, 1910: The transmission-line service was suddenly interrupted, throwing a load of 10,500 kilowatts on five 650-horsepower boilers. Oil was turned on under these boilers, which were at the time operating with coal, and steam pressure was held until the transmission-line service was restored. Moreover, the primary voltage at the substations was held within 1 per cent.

January 28, 1911: With the steam station carrying 2000 kilowatts on three 650-horsepower boilers, using coal, with three firemen on watch, the transmission-line service was suddenly interrupted and the load on the steam plant was increased to 8500 kilowatts. Oil was turned into eight additional boilers, and, although the steam pressure dropped from 175 to 165 pounds, it gradually came up to 175 pounds during the next 15 minutes. This drop in steam pressure was well within the range of automatic voltage regulators to maintain the primary voltage at the substation within 1 per cent.

May 12, 1911: The steam station was carrying 2000 kilowatts with four coal-fired boilers in service, and four additional boilers banked by means of one oil burner under each. The transmission service was suddenly interrupted and a load of 7600 kilowatts thrown on the steam plant. Oil was turned onto the four boilers in service and the four banked boilers; the steam pressure was maintained and in four minutes the boilers were blowing off.

Lignite Deposits in the United States

In an address on lignite, delivered before the American Philosophical Society, at Philadelphia, Penn., on May 5, by Joseph A. Holmes, director of the Bureau of Mines, the extent of the lignite deposits in the United States was shown by the accompanying figures, giving the areas in several of the States.

In several of the States in the Rocky Mountain region there are large areas of coal that represent a transition between typical lignite and bituminous coals. For these the name "subbituminous coals" has been suggested, and is tentatively used by the United States Geological Survey.

While the lignite beds in Alabama, Mississippi and Tennessee represent a transition between peat and the more typical lignites of the Dakotas and Texas, little or no use has been made of the lignite beds in these three States.

The lignites in Texas and Arkansas have been used to a limited extent, as have also the lignites of the Dakotas and eastern Montana. In this latter field the lignites contain 20, and in some cases more than 40, per cent. moisture. They slack badly and rapidly on exposure to the atmosphere, and this quality seriously interferes with their use and value for fuel purposes.

"The outlook for the utilization of lignites," said Mr. Holmes, "is favorable along three lines: First, in gas producers, without either drying or other treatment; second, in boilers of special construction, such, for example, as that installed more than a year ago at Williston, N. D., by the United States Reclamation Service, where lignite is used in its natural condition almost immediately after being brought from the mine, and, third, made into briquets. In this case the lignite should be thoroughly and finely crushed and dried to a moisture content of from 5 to 10 per cent., and then compressed while still warm into briquets."

LIGNITE DEPOSITS IN UNITED STATES

	Lignite, square miles	Subbituminous, square miles
Alabama	6,000	....
Tennessee	1,000	....
Louisiana	8,800	....
Arkansas	5,900	....
Texas	53,000	....
South Dakota	4,000	....
North Dakota	31,000	....
Montana	7,000	8,800
Wyoming	....	21,360
Washington	....	1,100
New Mexico	....	5,000
Colorado	....	5,910
Idaho	....	1,200
Total	116,700	43,370

Limited quantities of lignite from California, North Dakota and Texas have been made into satisfactory briquets at the Government mine-experiment station at Pittsburg, using the full-sized German briquetting press, which develops a pressure of from 20,000 to 25,000 pounds per square inch. In the cases just mentioned the briquets were made without the use of any binding material, a sufficient amount of tarry material remaining in the crushed and dried lignite to serve as a bond to hold the particles together in the briquet.

"It is believed," said the speaker, "that the investigations of the Bureau of Mines along this line will demonstrate that the lignite in Texas, the Dakotas and Montana can be made into briquets on a commercial scale, and that in this form the lignite can be used as a substitute for other domestic fuel in these regions." There is sufficient raw material in these States to last for some time.

Electrical Department

Especially conducted to be of interest and service to the men in charge of the electrical equipment

Electrification of Textile Mills*

By George P. Gilmore

The application of the electric drive to textile machines has reached the stage where many manufacturers, superintendents, engineers and mechanics are giving it much time and attention and I expect to see in the near future a large increase in its use. One result of the mill men's study of the question will probably be that textile and power-machinery manufacturers will make many alterations in the design and construction of their machines with a view to making them as a unit more adaptable one to the other and both to the requirements of textile manufacturing.

In my opinion, too much that is not true has been said about the cost of installation of electric power, its maintenance and economy, as compared with mechanical power, for the best interests of electric power, and too little regarding its real advantage.

Prime Movers

The steam turbine as a prime mover for the generation of electric power has no rival. It has none of the irregularities of the reciprocating engine, is more economical than a reciprocating engine, except possibly when the engine is new and operating at its most economical point of cutoff, and requires less floor space, oil and attention. Because of its high speed, the generator is smaller and consequently costs less and the exhaust steam from the turbine can be used for any purpose requiring low-pressure steam, as it contains no oil.

On test a 1500-kilowatt turbine has shown an economy of 17.22 pounds of water per kilowatt-hour at full load and 17.68 pounds at 25 per cent. overload, equivalent to 12.86 pounds per horsepower at full load and 13.2 pounds at 25 per cent. overload. Immediately after this test the turbine was run 2½ hours at 50 per cent. overload; then temperatures of the generator were taken and the windings showed a rise of 20 degrees Centigrade.

Safety

Thanks largely to the insurance companies, who have established a code of rules for the proper installation of electrical equipment, it is practicable to supply current from the generators to motors and lamps so that there is no danger of fire or of shock to operatives. In fact, there is much less danger from a well installed electric drive than from a mechanical drive.

The Motors

Modern motors are efficient, rugged and reliable and require very little care; they can stand heavy overloads for long periods without injury—in fact, I ran twelve 5-horsepower motors 58 hours per week for five months, developing 9½ horsepower each, and not one of them was injured or caused a shutdown. They may be placed in any position or location and arranged to drive shafts either horizontal or vertical or at any angle.

Of course, it is necessary to use different types of motors for various machines and locations. For motors up to and including 10 horsepower, simple oil switches are used for starting. For card rooms or other places where there is lint, fly or dust in the air, the squirrel-cage induction motor, which has no resistance coils in the rotor but has its starting resistance in a stationary closed case, is best suited; for other purposes or places an induction motor with an internal resistance may be used.

Some attention is now being given to variable-speed motors direct connected to cylinder shafts. In view of results obtained from one large installation where the motors were directly coupled to the cylinder shafts I am of the opinion that it is not necessary to change the cylinder speed with this drive as often as has been the practice with belted drives.

Table 1 herewith shows the results of spinning yarn at a constant spindle speed on frames having the same size rings in counts varying from 10 to 120 as compared with the production previously received from belted machines, using varying speeds and size of rings. The great increase shown in the production of 10s. was largely due to the fact that the mechanically driven frames were not properly equipped or fitted to spin this count.

TABLE 1. COMPARISON OF PRODUCTION RATES

Yarn	Twist per Inch	R.P.M. Front Roll	Pounds per Spindle in 58 Hours		
			Motor Drive	Belt Drive	Per Cent. Increase
10 C. P.	11.0	218	7.45	3.5	111.4
24 Card. P.	17.2	140	2.18	1.61	36.6
30 C. P.	19.2	125	1.56	1.36	14.7
34 C. P.	20.4	118	1.29	....	.....
35 C. P.	20.7	116	1.23	1.04	18.3
36 Card. E.	21.0	114	1.16	1.01	14.9
40 C. P.	22.2	108	1.01	0.87	16.1
45 P. Card	23.5	102	0.84	0.76	10.5
46 P. Card	23.7	101	0.83	0.74	12.1
50 C. P.	24.7	97	0.726	0.61	19.0
70 C. P.	25.14	89	0.48	0.33	45.5
108 Comb. S. I.	26.60	82	0.28	....	.....
120 Comb. S. I.	35.84	64	0.20	....	.....

Installation and Operating Costs

The following figures cover the costs of an installation using turbine-driven generators, individual motors on pickers, ring spinning and some twisting frames and group drives for cards, combers, sliver and ribbon laps, drawings, fly frames, mules, reels and spoolers. The prime movers are two 1500-kilowatt units. The total cost, including buildings, chimney, boilers, prime movers, all auxiliaries, motors, wiring, shafting, belting and all equipment, was $345,150. The cost per kilowatt of rated capacity, therefore, was $115.05, divided as follows:

	Cost per Kilowatt
Buildings, chimney and foundations	$19.22
Power-house equipment	65.64
Motors erected	18.44
Wiring	7.01
Shafting	3.76
Belting	0.98

This was an expensive installation, owing to the fact that the power house was built in water, requiring concrete foundations under walls, boilers and machinery as deep as 9 feet in many places, and it was necessary to construct water-

*Extracts from a paper read before the Master Mechanics Association of America at Fall River, Mass., May 19, 1911.

ways to and from the power house, costing $10,343.

It was originally intended to group-drive the ring spinning frames, but after the purchase of the frames it was decided to use individual motors and as it was impossible to get motors of the correct size for the number of spindles per frame, the nearest standard size, which was 25 per cent. larger than necessary, was used, thus increasing the cost per spindle for installation and decreasing the efficiency of the motor.

The costs of installation for frame drives were:

	Per Spindle
Ring spinning, individual drive	$0.53
Ring spinning, group drive	0.35
Ring twisting, group drive	0.60
Ring twisting, individual drive	0.89

TABLE 2. COMPARISON OF INSTALLATION AND OPERATING COSTS FOR RECIPROCATING ENGINE AND MECHANICAL DRIVE AND TURBO-ELECTRIC PLANT

	Engine and Mechanical Drive	Turbines and Electric Drive
Installation		
Plant capacity	4,000 Hp.	3,000 Kw.
Installation investment	$258,860	$345,150
Operation	Mechanical	Electrical
Interest, 5%	$12,943	$17,257
Insurance, 2½%	776	1,035
Depreciation, 5%	12,943	17,257
Taxes	2,790	3,726
Fuel ($4.50 per ton)	46,476	46,476
Wager	6,796	7,546
Repairs	1,000	1,100
Supplies	960	600
	$84,684	$94,997
Cost per horsepower per annum	21.17	23.75
Relative cost, per cent	100	111.2

Installation investment includes buildings, chimney, shafting, belting, motors, boilers and all power machinery and equipment.

TABLE 3. COMPARATIVE COSTS OF PRODUCTION FOR AN ENGINE AND BELT-DRIVEN SPINNING ROOM AND ELECTRIC INDIVIDUAL MOTOR-DRIVEN SPINNING ROOM, TO SPIN 38,362 POUNDS PER 58 HOURS OF NO. 46 COMBED PEELER YARN

Data	Mechanical	Electrical
Spindles	51,840	46,000
Horsepower	864	767
Floor space, square feet	50,100	44,390
Yarn per spool per 58 hours (pounds)	0.74	0.83
Labor and expense per pound	$0.02663	$0.02342
Power per horsepower per annum	21.17	23.75

TOTAL COSTS PER ANNUM FOR SPINNING ONLY

	Mechanical	Electrical
Interest, 5%	$14,076.00	$12,228.00
Insurance	844.00	733.00
Depreciation, 5%	14,076.00	12,228.00
Taxes	3,042.00	2,646.00
Power	18,290.88	18,216.25
Expense	51,079.00	44,922.00
Total	$101,407.88	$90,973.25
Cost per pound	0.0508	0.0456
Saving, per cent		10.23

Mules are a group-drive proposition as the great variations in power required during each cycle of their operation would require a very large motor, making the cost and efficiency prohibitive. In one case I applied an ammeter to a 200-horsepower motor driving 22,288 mule spindles and found the load varying from 125 to 250 horsepower.

For comparison of power costs between plants driven by reciprocating engines through mechanical transmission and those driven by turbines through electrical transmission, I have used the actual cost of the 3000-kilowatt plant previously referred to for the electric drive and carefully estimated the cost of an engine and belt drive of equal capacity, using figures submitted as prices by power-machinery manufacturers at the time this proposition was under consideration.

The fuel, repairs and supplies for the electrical plant and all figures for the mechanical drive are estimated. The efficiencies of the two types of drive are assumed to be equal. (See Table 2.)

From these figures it would seem to be necessary to find some material benefits to be derived from the electric drive over the mechanical to warrant the extra expenditures necessary for its installation and operation. In these figures I have tried to be conservative and, if either, favor the mechanical drive.

It is generally understood that the power costs amount to about 6 per cent. of the cost of production; therefore, if the production were increased two-thirds of 1 per cent., the 11.2 per cent. excess in power costs would be balanced.

In Table 1 I have shown the increased production of various counts obtained in one plant where the electric drive has been installed. Taking the results obtained on the count for which this mill was laid out as a basis for the comparison of a mechanical and electrical driven spinning room, the figures in Table 3 are obtained.

TABLE 4. RESULTS OF TESTS MADE TO DETERMINE THE POWER REQUIRED TO DRIVE VARIOUS MACHINES AND PER CENT. SPEED LOST IN TRANSMISSION

Operation	Drive	Motor Horsepower		Spindles				
		Rated	Actual	Per Horsepower	Per Frame	Total	R.p.m.*	Percentage of Loss from Drive to Spindle
Ring spinning	Bicycle Group Tight side of drive	150	115	79	240	9,120	7,880	3.6
Ring spinning	Loose side of drive	...	...	.....	...	.....	7,732	5.4
Ring spinning	Individual	5	4	60	240	240	7,854	0.0
Ring twisting	Bicycle Group Loose side of drive	150	145	42.81	280	6,208	5,573	5
Ring twisting	Tight side of drive, ¼ twist					5,720	Shaft Mch.	2.7 Shaft to Mch.
Jack frames	Group	100	75	65.23	4,900	275	486	1.8

*In computing the spindle speed ⅛ inch was added to whorl and cylinder.

NOTES:

Ring Spinning Group Drive. 1⅜" Ring—2⅜ oz. per bobbin—full bobbin. Avg. counts 30 Combed Yarn.

Ring Spinning Ind. Drive. Yarn 30 P. Co. B. T. Special Combed Peeler. 2⅜ oz. 1¾" Ring. Full bobbin.

Ring Twisting Group Drive. 2¼" Ring, 3⅜ oz. per bobbin. Avg. Counts 50|2 P. Co. Full bobbin.

Mule Spinning	Motor Horsepower		Number of Spindles	Spindles per Horsepower
	Rated	Actual		
	200			
Minimum		125	22,288	
Mean		185	22,288	120.4
Maximum		250	22,288	
Individual Drive				
Bale breaker	5	3.22		
Self-feeding opener	5	1.61		
Breaker lapper	5	9.65		
Finisher lapper	5	3.6		

No.	Machines	Motor Horsepower		Horsepower per Machine
		Rated	Actual	
64	Cards	50	45	0.703
24	Combers	15	15	0.625
16	Lappers	25	15	0.93

NOTE.—In mule spinning, average counts 12 hank, combed Egyptian—76 silk.
NOTE.—Peeler cotton was being opened during test on bale-breaker, opener and lappers.

It was found that an operative attended the same number of spindles at their increased production as before, that there was less breakage of ends, because of the constant speed and absence of belt slip; consequently better yarn was produced with less labor. The breaking of ends is not caused by the creeping of belts but mostly by short jerky slips such as occur when dry or hard spots in the belt get on the small driving pulleys.

Table 4 gives the results of tests made to determine the power required for dif-

ferent machines, as shown by electrical instruments, and the loss due to slippage of belts, bands, etc., between the drive and the spindle. It was found that the ⅛ inch added to whorl and cylinder fully compensated for the band slip on the individually driven spinning frames.

As spinning requires about 60 per cent. of the power used in a mill it is not strange that it has received more attention than other processes and therefore is in a more advanced state of development than the other drives.

Advantages and Disadvantages of Electric Power

Advantages—The advantages of electric power have been discussed by electrical engineers and power-machinery manufacturers in many papers on the subject, but are more fully understood and appreciated by mill agents, superintendents and mechanics who have daily experience with it and have a better chance of studying and because of their knowledge of the work required of it are better qualified to judge its merits.

Among the advantages and possibilities of the electric drives may be mentioned the following: Smaller power house and foundations; separation of power house and mill; economy of prime movers over a wide range of load; steady and even speed; no chance of wrecking the prime mover by a charge of water from the boiler; maximum use of the expansive power of steam; utilization of exhaust steam, because it is clean; more reliable power; more accurate knowledge of the power developed and used; information supplied by switchboard; absence of belt race and large belt troubles; less floor space required for a given output because of increased production; lower ceilings and lighter roof construction because of the absence of heavy shafting; better lighting because of the absence of belts; increased production; better machinery arrangement; more operating flexibility; lower operating costs; cleanliness; ease of determining machine troubles by applying electrical instruments; ability to stop all transmission by any employee in the room, and the ability to make use of purchased power as an auxiliary for overtime work, in case of accident, or to build a mill without a power plant.

Disadvantages—The principal drawbacks to electric power are the cost of installation and, in some cases, whether real or fancied, the cost of operation.

Cost of Engine Operation

I give in Table 5 the actual cost of power, which is an average for three years figured from well made and complete reports, developed by a reciprocating engine. This plant was probably as skilfully operated and well managed as the average plant in textile mills. The high repair item was caused by the reboring of all cylinders and ports and fitting same with new valves and pistons, which was done in the first year covered by the account. This may be of interest in showing that theoretical economies are not always obtained in practice.

TABLE 5. COST OF POWER PER YEAR PER INDICATED HORSEPOWER, AVERAGED OVER THREE YEARS, USING TANDEM COMPOUND CONDENSING ENGINES

Repairs	$ 2.25
Fuel @ $4.30 a ton	14.19
Labor:	
Boilers	0.775
Engines	1.09
Transmission	0.363
Handling coal and ashes	0.702
Supplies	0.24
Interest, 5 per cent	$ 3.25
Depreciation, 5 per cent	3.25
Taxes and Insurance, 1 per cent	0.65
Coal in storage, 5 per cent. on 4 months' supply	0.24
Total cost per year per indicated horsepower	$27.00
Equivalent cost per year per kilowatt	36.18

All costs given in this paper are prices of 1908 and 1909; the prices of electric machinery have since been lowered 10 per cent.

Discussion

In the discussion which followed the reading of Mr. Gilmore's paper, Sidney B. Paine, manager of the General Electric Company's mill power department, said that about 500,000 horsepower of electrical equipment has been installed in textile mills up to date. Among the large installations he mentioned 23,000 horsepower in the Amoskeag mills, 50,000 at Lawrence, 30,000 at Lowell, 68,000 in the various mills of North Carolina and 52,000 in those of South Carolina.

The average size of textile mill motors ten years ago, Mr. Paine said, was 75 horsepower, whereas the average size now is 23 horsepower; the change is due to the increased use of individual motors. He also said that the speed of motors used on all textile machines except mules would not vary 1 per cent., and cited a number of instances of increased production due to substituting motors for belt drives, notably with respect to looms.

An Easily Built Switchboard

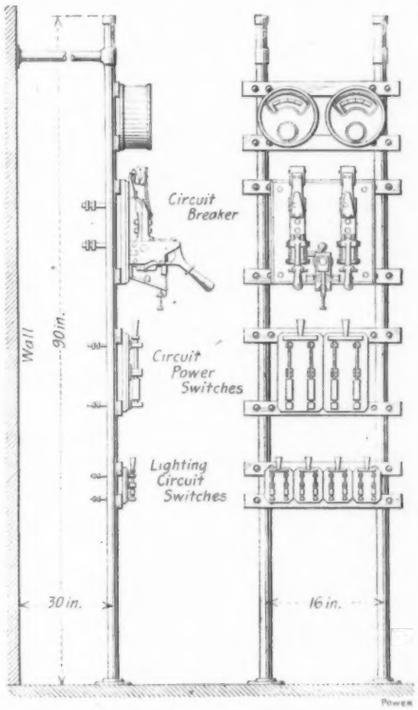
By J. B. Crane

The accompanying sketch shows an inexpensive and serviceable switchboard for use in small machine shops, woodworking establishments or other places where a few motors are to be installed and the owner does not wish to go to the expense of buying a conventional slate or marble switchboard and corresponding fittings. The uprights are 1¼-inch pipes set in floor-plates fastened to the floor, closed at the upper ends by ordinary pipe caps and braced to the wall by 1¼-inch pipes screwed into tees on the uprights and floor-plates on the wall.

The meters, circuit-breakers and switches are supported by pieces of oak or other hard wood ¾ of an inch thick by 2 inches wide, held in place by U-shape axle clips which can be secured at any blacksmith shop or carriage-hardware store. The wiring on the rear should be fastened to the boards by means of porcelain cleats.

The whole outfit can be painted black and presents a very neat, attractive appearance—in fact, it will look much better than a slate board will after being in use six months or longer. It is easy to add as many panels as are wanted and to change the switches at any time.

Such an arrangement can also be used



An Easily Built Switchboard

for mounting oil switches, starting compensators, etc., to be placed near the motor.

In a recent installation consisting of one 5-horsepower motor, one 10-horsepower, one 15- and one 20-horsepower motor, the contractor gave the same price on the total installation, using this style of switchboard, that was quoted for a slate switchboard, with its switches and circuit-breaker, but without the motors.

In a vessel of 5400 tons now under construction, the use of Diesel motors adds 15,000 cubic feet to the hold space. At four voyages a year in the Black Sea trade, this means a profit of $4380. The saving in fuel would be $2677, and in wages, $1168. It is also stated that a fishing boat of 140 tons equipped with a Diesel motor is doing the same amount of work in the herring fisheries as is performed by a steam-driven fishing boat of 164 tons.—*Scientific American.*

Gas Power Department

Everything worth while in the gas engine and producer industry will be treated here in a way that can be of use to practical men

Hot Tube Ignition

By Olaf Olafsen

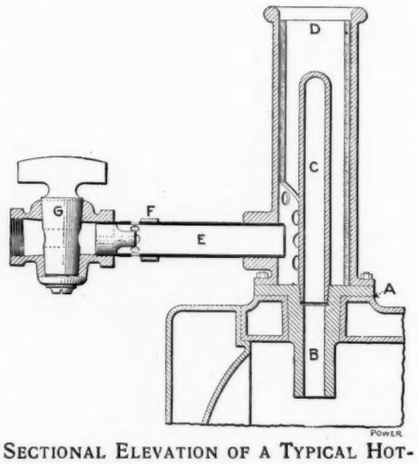
In these days the hot tube is tabooed and not even given consideration by many intelligent men in the gas-engine industry. However, there are thousands of hot-tube igniters in use and a good many are built and sold yearly; consequently, there must be a number of men to whose lot it falls to take care of gas engines equipped with hot-tube ignition. From personal contact with many mechanics, I know that the hot-tube igniter is not universally understood and this article is intended for the benefit of those who are not clear on the subject.

The drawing represents what is most common practice in hot-tube construction today. Mounted upon a pad *A* on the cylinder head or cylinder proper is a flanged bushing *B*, into the upper opening of which is screwed a tube *C* with one end closed. Surrounding this is a chimney *D*, usually of cast iron with an asbestos lining and a boss on one side for the entrance of the bunsen burner *E*. Around this boss are air holes for the admittance of air to prevent the gas flame from smothering in the chimney or from going to the top to get the oxygen necessary to complete combustion.

The bunsen burner is usually made up of a short length of brass tubing with a drilled plug forming the gas orifice at one end. A number of small holes arranged circumferentially about the tube, at a distance from the end about equal to the total length of the orifice plug, forms the air inlet. The amount of air admitted is regulated by a small sleeve *F* which is arranged either to screw or to slide over the holes.

The adjustment of the bunsen burner is one of the most frequent duties of the trouble man. It should never consume more than ten feet of gas an hour for any size of engine and in most cases six feet should be sufficient. Usually an attempt is made to regulate this consumption by means of the cock *G*. This is entirely wrong in principle because it cuts down the pressure and therefore the velocity of the gases flowing through the orifice, and as the amount of air drawn in through the inlet holes depends on this velocity it follows that the air supply will also be cut down and it will be difficult to secure a proper flame.

The proper way to remedy excess of gas is to peen the orifice partly shut and then ream the hole with a fine taper reamer until the proper amount of gas, that is, that just sufficient to heat the tube properly, is allowed to pass. These reamers, ranging in size from a fine needle to a darning needle, may be bought at most large hardware stores for an insignificant sum. A piece of octagon tool steel drilled at one end with a common lathe center drill forms an extremely convenient and mechanical set for closing up the orifice of a burner such as the one shown in the sketch. When the flame hovers at the top of the chimney it is a sure sign that too much gas is being burned or that either the air inlet holes in the burner or those in the chimney are clogged with dirt or that the air sleeve *F* is not properly adjusted and is admitting too much air. It is impossible for the manufacturer to make the gas orifice just right, as local gas pressures vary to such an extent. Should the bunsen tube cause trouble by burning back at the orifice it is probable that not sufficient gas is being delivered and that the orifice should be made larger, or else that the air sleeve *F* is not open far enough. Of course, this may happen in lighting the burner if the flame is applied before the mixture has had sufficient time to fill the tube *E* and attain some velocity through it.



Sectional Elevation of a Typical Hot-tube Igniter

In piping the burner to the source of supply, it is best and often necessary to take the gas from the illuminating pipe line; if taken from the power-supply pipe, it must be drawn from the meter side of the gas bag to avoid the fluctuations in pressure set up by the intermittent suction of the engine. In certain cities a gas bag is prohibited and small gasometers are used which are sealed with oil. To prevent starting the engine with the main gas cock closed and thereby drawing the sealing fluid out of the gasometer into the pipes, the hot-tube connection is taken off between the shut-off cock and the gasometer, on the meter side of the engine; this insures that the tube will never be heated sufficiently to start unless the main gas cock is turned on.

The chimney *D* is a simple casting. The asbestos lining should always be kept intact, as the proper heating of the tube is assisted by it. The tube is usually made of a piece of wrought-iron pipe with the end welded over or a piece of nickel-steel rod having a hole drilled almost its whole length. The nickel-steel tube is far preferable, its life being from six months to a year, under average conditions, while a wrought-iron or mild-steel tube may last only a few days or weeks. The thread is usually either ⅛ or ¼ inch, gas-pipe size. In former times, porcelain and platinum tubes were used, the former being abandoned probably on account of their brittleness and the latter on account of their cost.

A very important, although apparently minor, part of the hot-tube apparatus is the bushing *B*. First it would probably be best to explain the manner in which the ignition is timed with a hot-tube igniter. I can see the younger gas-engine men smiling at this, but I have seen many hot-tube diagrams showing a regularity of successive explosions which compared favorably with any of those produced by a engine equipped with electrical ignition. It will be evident from the sketch that there is no chance for the tube and the hole in the bushing to be scavenged on the exhaust stroke; therefore, when the piston starts back on the compression stroke with a full charge of fresh gases in the cylinder, these will be forced up through the bushing, compressing the burnt gases ahead of them and possibly mixing for a certain distance beyond the line of contact with them, but this is unimportant as the amount would be practically constant. When the piston has advanced

far enough to cause the fresh gases to rise to that part of the tube which is at the ignition temperature, they will be ignited and will shoot a tongue of flame down into the charge in the combustion chamber and ignite it.

Calling the part of the tube and bushing below that point which is heated to the ignition temperature the cool length and the part of the tube above that point the hot length, and bearing in mind the fact that the movement of the fresh gases up the tube will be nearly proportional to the piston displacement at each part of the stroke and that the length of the column of burnt gases will shorten somewhat under the compression, it is clear that a longer bushing, all other conditions remaining the same, will cause ignition to occur later in the compression stroke, because the ratio of hot length to total length is smaller; on the other hand, a longer ignition tube will cause earlier ignition, because the ratio of hot length to total length is greater. Of course, this will not conform rigidly to the laws of compression, as there are too many variables; the proportions must be established experimentally for each design of engine. Further reasoning will show that enlarging the bore of the bushing will cause later ignition, the bore of the tube remaining unchanged.

An example of how these dimensions work out in practice is given in the accompanying table, which presents the practice of one well known engine builder. Unfortunately I am unable to give the exact hight of the bunsen tube above flange here, although it is very close to one inch to the center of the tube. Occasionally the length or bore of a bushing must be changed for some engine which does not come up to the usual performance. This occasions no trouble as a record of the bushings is kept under the shop numbers so as to fill repair orders properly.

It is advisable for a mechanic engaged in adjustments on hot-tube engines not to tamper with either the original length or bore of either the tube or the bushing unless he is prepared to make a thorough test with indicator, brake and gas meter to prove that he is working in the right direction; the long experience and careful work of reputable engine builders are far more efficacious than haphazard field methods. Adjustment of the bunsen burner and of the fuel mixture delivered to the engine will usually cure any ignition trouble. Serious loss of compression is liable to make ignition late and even uncertain, but the fuel mixture in the engine cylinder has considerable effect on the performance of hot-tube igniters. A rich mixture will hasten the rise to maximum pressure and a lean mixture will delay it; I am not able to say just how the mixture affects the rate or the timing of ignition, however.

The bushing *B* is an important part of the apparatus for further reasons.

Upon one occasion I was called to examine an engine which usually "laid down" about twenty minutes after the full load was applied, the shutdown being accompanied by heavy pre-ignitions and backfiring. Upon reaming the hot-tube bushing I found that it was made of a piece of wrought-iron pipe screwed into a flange and that the joint between the flange and the cylinder was packed with a heavy asbestos gasket. There was also about ¼ inch clearance all around the tube in the passage by which it connected with the cylinder. The tube had scaled and wasted away until it was very thin, showing that it had often been above red heat. The cure in this case was to substitute a cast-iron flanged bushing in one piece, with the same size of hole and of the same length, made of sufficient outside diameter to fit the hole through the cylinder wall and having a ground joint instead of packed one, thereby allowing the heat to be conducted away to the water jacket and keeping the bushing reasonably cool.

HOT TUBE IGNITER PROPORTIONS.

Bore and Stroke.	R.P.M.	Average Compression, Lbs.	Length of Bushing Under Flange.	Thickness of Flange.	Diameter of Hole.	Length of Nickel Steel Tube.
4½ × 10	300	69	2½			4½
5½ × 12	275	..	2½			4½
6 × 14	260	90	2½			4½
7 × 15	250	91	2½			4½
8 × 15	220	94	3½			4½
9 × 16	210	79	3½			7

Had it been possible, the best arrangement would have been to raise the bushing, keeping the original length of hole, so that it projected very little into the combustion space, the free end extending into the combustion space always being liable to overheat unless properly protected as described. This is best placed where the entering charge will sweep over it and keep it cool. Of course, this would cause considerable backfiring if the proper precautions were not taken to conduct a large part of the heat to the water jacket.

In former years many attempts were made at positive timing of hot-tube ignition, this usually being accomplished by a valve actuated by the cam shaft opening the passage to the hot tube at the proper instant. These were of little value as the valve faces and seats were short-lived. Mechanical timing is not advantageous on engines up to 15 horsepower unless operating on gases containing an extremely high percentage of free hydrogen; in such cases it would be far better to employ some other ignition system.

To the best of my knowledge the insurance companies do not distinguish in their rates on gas-power plants between hot-tube and any other method of ignition unless gasolene supplied from a small elevated tank (as is usual with gasolene engines) is used to heat the tube. This is manifestly an extra risk and such an installation should never be allowed except in a small, absolutely fireproof building, such as might be used for a small private plant located in large grounds.

The Status of Gas and Oil Power*

By J. B. Klumpp

The economy of operation of gas-power plants was shown in last year's report to be considerably better than that of steam-power plants, except possibly in those stations where steam-turbine units of larger sizes and most approved design were installed. It is believed that for plants of, say, 2000 horsepower and under, the fixed charges due to investment for gas-power plants, including producers, should not exceed the fixed charges of steam-power plants, including boilers, and it is also believed that the depreciation charges for gas-power plants should not be greater.

What may be considered one of the greatest incentives for the introduction of the gas producer and gas engine is the utilization of low-grade fuels which are unsuitable for use in steam-power development, such as the lignites of Texas, Colorado and Washington State, and the low-grade refuse fuels, as the "culm" of the anthracite-coal mines and the "bone" of bituminous-coal mines. From tests made by the United States Government, and also from the operation of plants installed in the above named districts, it is acknowledged that lignite coal with a high percentage of ash can be handled with efficiency, and from reports of plants in operation, both in this country and abroad, the tailings of coal mines having percentages of as high as 50 per cent. have been used with more or less satisfaction. In view of this fact, it is obvious that many gas-producer power plants will continue to be installed throughout certain sections of the United States where such low-grade fuels are in abundance and that central power stations will be erected to distribute electric power at high tension from these points.

The use of anthracite fuel has been successful in a great many types of gas producer and it is a matter of very little moment which type is adopted for the purpose of handling this kind of fuel—either the updraft, downdraft, suction or pressure type—but the use of bituminous fuels is more complicated and has necessitated the adoption of methods that will produce a gas free of tar and lampblack. For this purpose various manu-

*Part of the report of the Prime Motive Powers Committee, presented at the recent convention of the National Electric Light Association.

facturers have so designed producers that the tar will either be consumed in the fuel bed, or if appearing in the resultant gas, will be removed by means of special tar extractors. Producers of this type are being made updraft, downdraft and double zone forms and it is fair to say that for a perfect utilization of the fuel at hand, certain modifications must be made in the design and operation of each type of producer to suit the local fuel conditions. In Europe, where the use of gas-producer plants has become more of a general proposition on account of the relatively high cost of fuels and low cost of labor, the adoption of the by-product installation is more prevalent where bituminous fuels are used than it is in this country. From such by-product installations a relatively high return can be made from the residuals in the shape of tar and ammonia, but this factor has not been seriously considered in this country, owing to the relative cheapness of fuels and expensiveness of labor; also on account of high cost of the plant necessary to work up these residuals.

During the last few years the design of the gas engine has been simplified in many ways and, while there have been no radical changes in the general type, the construction has been improved by added refinements in the details of the mechanism, and more particularly in the adoption of high-grade materials and the appreciation of the resultant strains and stresses that take place in these materials. This general tendency to improvement has enabled the manufacturers to lighten the engine, reduce the number of working parts, simplifying the machine as a whole and at the same time this general improvement in design and construction has increased the reliability and reduced the repairs of gas engines.

Changes in valve gear have been made by some German manufacturers in returning to the throttling governor. In the same country they also show a tendency to adopt the Lodge system of ignition, which system has no moving parts to the spark plugs, the current being supplied from storage batteries and intensified by Leyden jars, producing a system similar to the ordinary automobile system of ignition.

One of the objections to installing gas-engine units, introduced more particularly by the industrial people, has been the want of auxiliary steam for heating and other purposes, which auxiliary steam is so convenient when a steam-power plant is installed. The opportunity to increase the economy of a gas-engine plant by utilizing the waste heat of the engine jacket water and engine exhaust is apparent and the attempts to do this so far have met with more or less success, but further developments must be made before it can be said to be successfully accomplished.

In discussing the internal-combustion engine, we must not omit those engines utilizing a liquid fuel directly in the cylinder. Such types of engine will always be in demand where the liquid fuels are obtainable at a reasonable cost. The gasolene engine may be included in this classification (this engine having its own special functions, when the high cost of fuel does not prohibit its operation), but in this discussion the heavy-fuel-oil engine only is considered. The method now generally adopted of obtaining power by the combustion of this liquid fuel creates excessive internal pressures in the engine cylinder, which necessitates a high-grade, expensive and heavy engine being built to withstand the pressures. Their use in the past, however, has been very satisfactory, and improvements in design, now constantly taking place, are reducing both their weight and cost. Many engines of this type have been installed during the past year by the American Diesel Engine Company, recently reorganized and now of St. Louis, and the De La Vergne Machine Company, of New York City.

In submitting this report it is desired to bring before the association the fact that development on this line of construction is progressing, and that there are many instances where the gas engine and producer may be installed for our own central-station practice that will prove beneficial to the operator by the economies that will be obtained. The introduction of gas engines for central power purposes will be continued where gaseous fuel is obtainable, either as a byproduct, in the case of coke-oven operation, or where natural gas is available, as the installation of such engines will give economies far exceeding the utilization of the same fuel when consumed under steam boilers. But when such cheap gaseous fuels are not obtainable, the installation of a power plant in each individual case should be carefully studied and the installation, whether gas or steam, should be made on its own merits.

LETTERS

Inspection Plugs for Poke Holes

Mr. Lee's inspection plug, mentioned in the issue of May 16, is worthy of more than passing interest. It is a new application of an old method used by brick and tile manufacturers to determine the temperature of the brick and tile on the inside of a kiln. It had been suggested while the mason was sealing up the kiln door. A piece of 1½-inch pipe 12 inches long was set in the brickwork through the door and when the job was completed a thick piece of window glass was cemented over the outer end of the pipe. This soon smoked up from the dampness of the brickwork and the fresh green fire and the cement cracking allowed the glass to drop from the end of the pipe. The pipe was then plugged with clay until the fires were built up and the contents of the kiln began to turn red; then the clay plug was removed and the glass replaced. This proved very successful and several peep-hole plugs were made in the other kiln doors as well as side walls. We could not obtain mica in those places and the glass had to serve the purpose. The length of the pipe seemed to be such as to provide sufficient dead air insulation to prevent the heat from cracking the glass. I have since seen peep-hole plugs of this kind in use in forge shops for watching the "heat" temperature rise on the work within the forge without opening the door, which would chill the work on the side nearest the door.

R. A. CULTRA.

Cambridge, Mass.

Corrosion of Water Cooled Exhaust Pipes

In reply to the inquiry under this heading in the May 9 issue, I would say that the preferred method of cooling the exhaust pipe of a large gas engine is by means of a closed water-jacket around the outside of the exhaust pipe proper, the cooling water discharge from the engine jacket passing upward through the pipe jacket. The diameter of the inner pipe should be 10 to 30 per cent. larger than that of the engine exhaust valve to allow the pressure and temperature to drop rapidly. For the first 10 feet of pipe from the engine gray cast iron is most suitable. If bends are required, they must be of large radius. As ample provision for expansion is required, slip joints and rollers under the pipe are necessary.

If internal water injection is applied corrosion is bound to follow, but it can be much reduced by using, as far as possible, extra heavy glazed vitrified acid-proof sewer pipe. Possibly the vitrified portland cement conduit shells, made in halves, in sections three feet long, described in POWER of April 11, can be utilized for this purpose. To enable this type of conduit to withstand the pressure of an occasional explosion in the exhaust pipe, the conduit may be enclosed in a cast-iron or steel pipe, the space between being filled with portland cement grouting; or a thick inclosure of concrete alone will probably hold. Concrete conduit without any protective lining will not stand up as well as it is porous and likely to disintegrate. No matter what construction is used, provision must be made for expansion and for cleaning and draining.

CHARLES H. HERTER.

New York.

Readers with Something to Say

Practical information from the man on the job. A letter good enough to print here will be paid for. Ideas, not mere words wanted

Check Valve in Blowoff Pipe

A few years ago I was engineer in a plant containing two 60-inch by 16-foot return-tubular boilers, set in one battery. The blowoff pipes connected to a single pipe in the rear which led to the sewer. Boiler No. 1 was cut out for cleaning. When I entered the boiler I forgot to close the blowoff valve. After inspecting the inside I had just crawled out when the fireman opened the blowoff valve on No. 2 boiler and steam and hot water rushed into No. 1 boiler. Had I been a minute later I would have been scalded. The next week I got two 2-inch swing check valves and put one in each vertical pipe so that the valve would open to the sewer.

The fireman said it was only wasting brass putting them in. He is now engineer at the plant, and on a recent Sunday was in No. 2 boiler when his fireman opened the blowoff on No. 1. The hot water and steam rushed up the blowoff pipe and striking the disk closed the check in the blowoff pipe of No. 2 boiler. He told me that the check valve had saved his life, as he was directly over the blowoff pipe, examining tubes and braces. His candle was extinguished and enough hot water and steam got by the check to scald his arm slightly. The check is always open and does not interfere with the blowing off of the boilers and requires very little pressure in the opposite direction to close it.

EDWARD HENLOW.

Camden, N. J.

Friction Load Diagrams

The pair of friction indicator diagrams herewith presented in Fig. 1 are worthy of study. They were taken from an 8x10-inch Ames engine having a 1¾-inch piston rod; the engine ran at 250 revolutions per minute. The diagrams are of the friction load. An outside-spring indicator was used with a 60 spring. The reducing motion was of the pendulum type and the indicator cord was about 2 feet long.

There is no reason for believing that the diagrams do not truly represent the action of the steam in the cylinder, although they may contain some unsuspected error. Under the same no-load running conditions the engine produced diagrams identical to these shown, on different days. It seems, therefore, that the peculiarities of the crank-end diagram are due to the valve action and, possibly, to heat interchanges between the steam and the cylinder walls. That the valve is properly set for normal load is shown by Fig. 2.

The point of release *R*, Fig. 1, distinguishes the expansion line *E* from the compression line which crosses it. Assuming the diagrams to be correct, it appears that some exhaust steam is trapped in the crank end of the cylinder and compressed during the return stroke to the highest pressure. It also seems that no live steam is admitted to the crank end as the pressure does not rise as high as on the head end and the steam line falls vertically, instead of rising, at the beginning of the stroke. If this interpretation is correct, negative work is done in the crank end, the piston compresses exhaust steam, which in expanding does not return all the work put into it. Upon this basis, the crank-end horsepower is minus 1.26. As the horsepower at the other end is 3.37, the friction horsepower is 2.11.

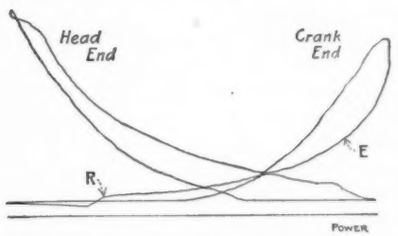


FIG. 1. DIAGRAM OF FRICTION LOAD

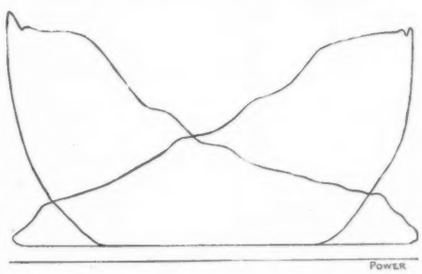


FIG. 2. FULL-LOAD DIAGRAM

The peculiarities of the crank-end diagram suggest the following questions:

Why does the steam line fall vertically at the beginning of the stroke?

Why does the expansion line cross the compression line?

Why is the back pressure after release less than during the return stroke before compression?

JULIAN C. SMALLWOOD.

Syracuse, N. Y.

Removed Flywheel Blocking

At one time the plant of which I was chief engineer was shut down for repairs. After the boilers had received a thorough overhauling, the firemen were called in to help put things in shape for starting up. Part of the work was the installation of new piston-ring packing in the blowing-tube cylinder of the vertical 42 and 84 by 60-inch blowing engine.

The engine flywheels had been properly blocked and I was sure that no movement could occur, but some of the men who were putting in a new electric-lighting outfit, wanted some blocking and removed it from the flywheel. This left the large engine unprotected and placed lives of three men working in the blowing tub in jeopardy.

Entering the engine room I noticed that the blocking had been removed and lost no time in getting a piece of steel rail, and placing it between the spokes of the flywheel to prevent it from turning. Then I told the men to drop everything and come out.

A commotion was heard inside as three men, one of them a nervous Swede, tried to get out of the manhole at once. Finally, the two men managed to break the Swede's hold and one held him down while the other climbed out. When the Swede got outside he bolted for the door and that was the last I ever saw or heard of him.

The piston remained in place for about 10 minutes more. I had just got the boys to work blocking the wheel once more, when the rigging gang, hoisting a connecting rod into position on one of the other vertical engines, let go of one end which swung with considerable force against the blowing tub. The flywheel immediately turned, but the rail stopped it before the piston moved more than 36 inches of its stroke. The rail certainly did its work for the three men would have been killed had the piston moved when they were working inside.

I read an account some time before this occurred where two engineers were killed because they neglected to properly block a flywheel while working in a cylinder.

D. L. FAGNAN.

New York City.

Putting in Gage Glasses

When putting in gage glasses I have noticed that in nearly every case the little washer that is furnished with the connections is put in the bottom of the nut on top of the gasket.

The proper place for it is between the gasket and the threaded end of the connection.

The washer in this position makes a division between the gasket and the connection and the nut can be turned without the gasket sticking and bunching up in the connection, as it is almost sure to do if the washer is not properly placed.

I have found it good practice to smear the glass and washer with finely powdered graphite, before putting them in place. This prevents the gasket from sticking to the glass, which will crowd the glass and possibly cause it to break. The graphite should be put on dry, as oil will rot the rubber.

JAMES W. LITTLE.

Fruitland, Wash.

Faultily Marked Corliss Valve

A simple 16x24-inch Corliss engine pounded badly. Each shift engineer took a turn at setting the valve according to the data given by the factory blueprint, and they had failed to stop the pound. The bearings were carefully taken up, but the trouble still continued.

The chief engineer was advised of the trouble and after noting the action of the engine decided it was due to improper valve setting, notwithstanding the fact that the valves were set as per instructions.

The blueprint gave the lap with the wristplate in mid travel as 3/16 inch for the steam valves and 1/16 inch for the exhaust valves, and the lead with the valve gear hooked up and the crank on the dead center as 3/32 inch.

The chief got out his indicator and took a diagram and then adjusted the cutoff rods and took a second diagram. The lack of compression and also the fact that the exhaust was late, causing the toe of the card to point decided him to advance the eccentric. Another diagram was taken which indicated that the engine needed more of the same medicine, but the steam was being admitted too early and caused a hump on the top of the card; also advancing the eccentric alone a reasonable amount would not give quite enough compression. He, therefore, lengthened each exhaust-valve rod a turn and the steam-valve rods a turn and a half each and then advanced the eccentric another ¼ inch on a 6-inch shaft. As a result the pound had disappeared.

Upon examining the factory marks on the valves and eccentric, the steam valves had ⅜-inch lap, and the exhaust valves had ⅛-inch lap when the wristplate was in mid travel. Then the engine crank was placed on the dead center and the steam valves had 3/32 inch lead as per factory direction.

The eccentric had been advanced on a 6-inch shaft so that it stood ¾ inch, by the old marks on the shaft, ahead of its original position.

H. P. PORTER.

La Fundicion, Peru.

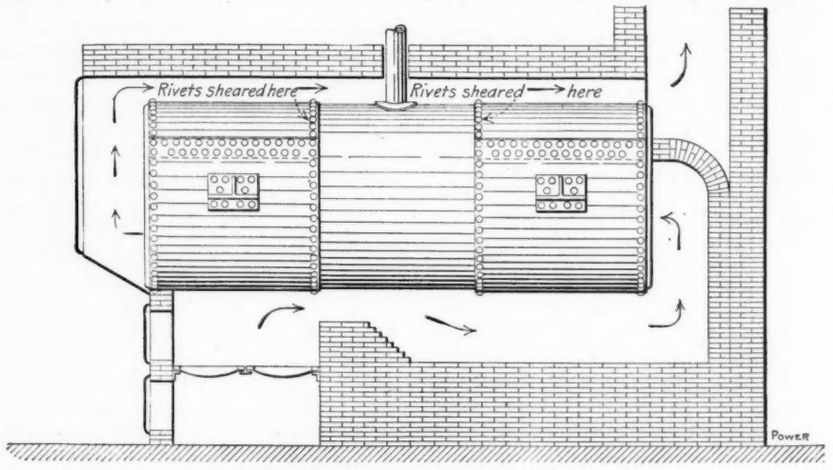
A Boiler Explosion Averted

"Some years ago," said an old engineer, "I took charge of a newly installed power plant. There were two 70-inch by 16-foot return-tubular boilers.

"These boilers had been put in with the idea of superheating the steam by bringing the hot gases back over the top of the shell, as shown in the illustration, the stack being located at the rear end of the boiler.

"Things went on apparently well for a few weeks, but one day I noticed water oozing through the brickwork near the top of the setting.

"It called for an investigation, and upon going in on top of the shell, it was found that in the seam nearest the fire, the rivets had begun to shear, some having been sheared over ⅛ inch. The plates had been left entirely unprotected and as there was nothing but steam on the inside, the seam had begun to give way.



SHOWING WHERE RIVETS SHEARED

"A boilermaker was called and the needful repairs made, after which the top of the shell was covered with fine loam, and no more trouble was experienced. The other boiler was also taken off and the same conditions were also found to exist on the end plate."

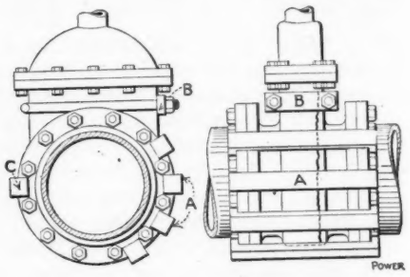
EDWARD T. BINNS.

Philadelphia, Penn.

Temporary Valve Repair

An emergency repair job was recently made on an 8-inch gate valve that was in a water line and split, as shown in the illustration.

The valve was drawn together by four ⅝x1½-inch iron clamps *A*, shrunk on as shown. A yoke piece was made to fit around the neck of the valve, the ends



HOW THE VALVE WAS REPAIRED

being threaded for nuts which held a cross piece *B* in place on the cracked side of the valve neck. The clamp *C* was used to hold against the other four clamps. This arrangement completely closed the crack.

W. E. DEAN.

Superior, Wis.

A Drip Problem

There are two lines of steam piping in the plant where I am employed, one a 12-inch heating main, the other a 2½-inch auxiliary steam main; each pipe is fitted with a reducing valve in the engine room. The boiler pressure is 110 pounds per square inch and is reduced to 5 pounds for heating purposes and 70 pounds for the auxiliary steam lines. The piping was arranged as shown in Fig. 1 before making the change, the drip being piped as shown at *A*. It was made up of 1-inch pipe, taken out of the bottom of the 12-inch ell. A ¾-inch drip was taken out of the tee on the 2½-inch line, with valves placed as shown; both drips were connected to one outlet.

In order to drain the 12-inch main, a hose was connected to the 1-inch drip valve and discharged out of doors. After opening the valve it sometimes required over an hour to drain the pipe. The ¾-inch valve *A* was shut all the time and the steam in the 2½-inch line took what condensation there was over into another building. In the engine room the pipes dropped down a distance of 8 feet and ran out through the wall into a conduit across the street, then into another building, where it ran up 12 feet and overhead to three other buildings. This was an unhandy and dangerous arrangement and caused frequent rumblings in the 12-inch heating main, due to water. This necessitated getting busy with the hose and drawing the water out through the drip valve. If anything should happen to the valve *A*, and the drip valve were shut, as is always the case except when drawing out the water, the steam would have a direct flow into the 12-inch main and the high pressure might burst some of the radiators.

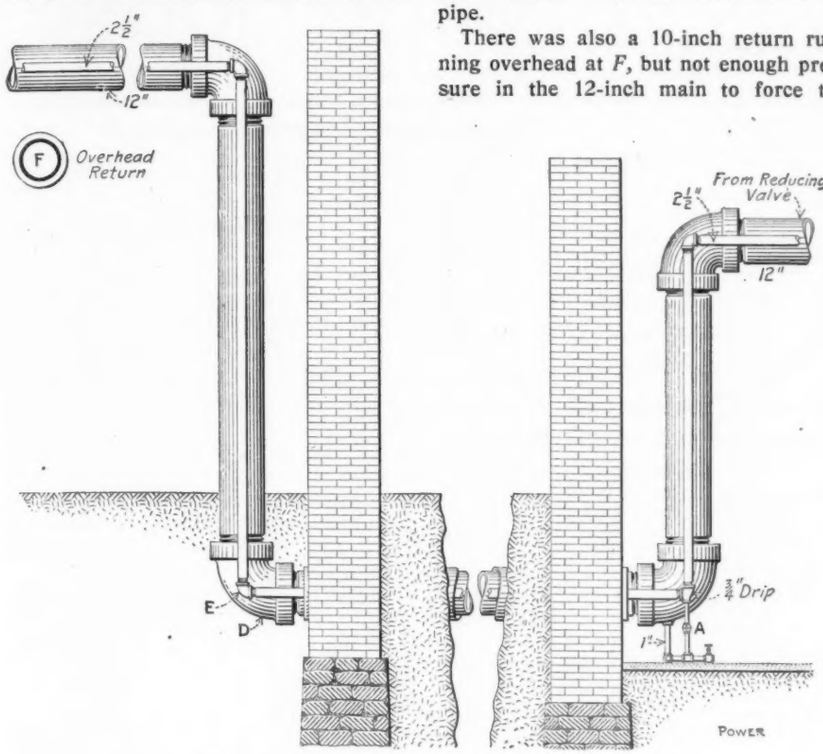


FIG. 1. ORIGINAL ARRANGEMENT OF PIPING

Changing this system of piping was not as easy as it would seem. To drain both lines at *A* would mean using two traps, one for the high- and one for the low-pressure steam pipes. I could not put the low-pressure trap at *A* because there was insufficient pressure to discharge the condensation from the trap overhead and across the engine down into the receiver, and there was no space under the floor. Both pipes on leaving the engine room had a slight pitch toward *D* and I determined to drain the lines at that point. The main return pipe from the buildings ran a distance of 20 feet from *D* and 8 feet underground in a 10-inch conduit made of cast-iron water pipe.

There was also a 10-inch return running overhead at *F*, but not enough pressure in the 12-inch main to force the water into it against the low-pressure in the pipe if using an ordinary separating trap. Having an old return trap, I overhauled it and connected it as shown in Fig. 2. I broke the elbow at *E* and arranged the piping as shown. I also drilled and tapped a hole in the bottom of the 12-inch ell, and made a connection to the automatic valve at *N*. The discharge was piped to the return pipe *F*. A 1¼-inch relief valve was put in this return pipe and set to blow at 10 pounds pressure so that if anything should happen the valve *N* would not shut tight and the pressure could not increase to a dangerous point in the heating system. The pipe *O* supplied the trap with steam and also drained the 2½ line of condensation, thus draining both lines with one trap.

AUSTIN FALES.

Mattapan, Mass.

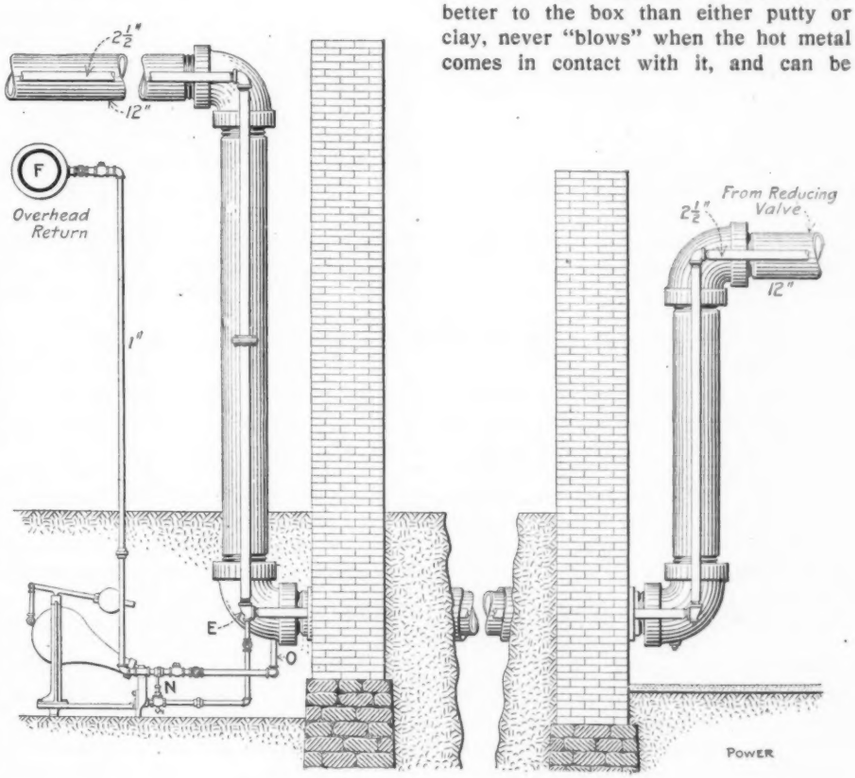


FIG. 2. SHOWING TRAP CONNECTION

Mixture Used in Babbitting Bearings

While visiting the power plant of the Anderson Traction Company recently, at Anderson, S. C., my attention was called to a little wrinkle in babbitting boxes.

Instead of using putty or clay for plugging up the ends of the boxes while the babbitt is being poured, some old asbestos pipe covering is ground up and mixed with cylinder oil to the consistency of a stiff putty. This mixture has these advantages: It is proof against the softening influence of heat, sticks far better to the box than either putty or clay, never "blows" when the hot metal comes in contact with it, and can be used over and over without loss or hardening.

S. KIRLIN.

New York City.

Questions Before the House

Comment, criticism, suggestions and debate upon various articles, letters and editorials which have appeared in previous issues

Did Not Hook On

I submit the following to S. E. Mead, regarding the indicator diagram from the low-pressure cylinder of a cross-compound engine which appeared in the May 23 number. While the diagram from the end which did not hook on shows area, it is negative area. Starting with the piston at the beginning of the stroke, the pressure at this point is due to the compression of the steam trapped by the exhaust valve on the preceding return stroke. While the engine is passing the center this steam loses some of its heat and therefore the expansion line does not follow out the compression line. In this case the expansion line is the lower line of the diagram. The steam on the forward stroke will have to expand to the point of release, which would give a constant drop in pressure if no more steam was admitted to this end of the cylinder. The area of the exhaust port for a velocity of 4000 feet per minute would be about 200 square inches or for a velocity of 6000 feet per minute about 135 square inches.

At the middle of the expansion stroke the steam below the exhaust valve is about 5 pounds higher than that in the cylinder. Taking the smaller area,

$$135 \times 5 = 675 \text{ pounds}$$

lifting this valve from its seat. I believe this exhaust valve lets a little of this steam into the cylinder and holds up the expansion line.

After the compression begins in the opposite end of the cylinder the condenser removes the excess pressure down to the upper line of the diagram under discussion, the exhaust valve opening, and the pressure in the cylinder raises to that in the exhaust pipe connecting with the condenser.

On the return stroke this pressure holds nearly constant, rising a little with the velocity of the returning piston until the closing of the exhaust valve, when the steam is compressed to the highest point of the diagram, losing some heat and pressure as the piston is nearly stationary when the crank is passing the center.

LESTER FITTS.

West Fitchburg, Mass.

Mr. Mead asks why this diagram has any area, why the expansion line does not follow back on the same line as the compression, and why the expansion line runs practically parallel with the atmospheric line.

In experimenting with an indicator a few weeks ago, I prevented one steam valve from hooking on and took an exact duplicate of Mr. Mead's card except that mine was from the high-pressure cylinder.

Consider the diagram to have been taken from the head end of the cylinder and start the diagram just as the piston starts to move from the crank end; steam is then exhausting into the condenser through the head-end exhaust valve. This subjects the cylinder and the indicator connected to the head end to the pressure existing in the condenser, which is practically constant and therefore accounts for the line parallel to the atmospheric line which Mr. Mead calls the "expansion line," when it really is the exhaust and compression line. When the exhaust valve on the head end closes for compression this line takes an upward turn; this is the compression line which ends as the piston reaches the head end of the cylinder.

As the piston starts on the return stroke the steam valve does not open, the exhaust valve is also held closed, the small amount of steam compressed in the head end condenses and expands rapidly, as the volume increases, until it reaches a point lower than the pressure in the condenser; just how much lower this will be than the pressure in the condenser depends on the tightness of the valves and piston.

The area represented by this diagram is work done in moving the piston against the unbalanced pressure between the condenser and the head end of the cylinder. This work is done during this stroke by the flywheel.

A consideration of the different events and their relation to the diagram should make the diagram plain.

C. B. HUDSON.

Lowell, Mass.

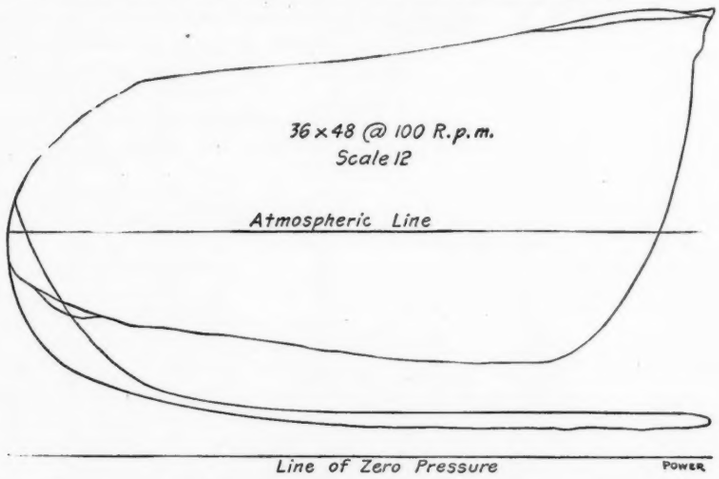


DIAGRAM FROM LOW-PRESSURE CYLINDER OF CORLISS ENGINE

Getting a CO_2 Recorder

The article in the issue of May 9 on The Value of the CO_2 Recorder, written by H. S. Vassar, was very interesting.

I am the mechanical engineer for a Nevada concern engaged in the mining and reduction of copper ores. We have a 10,000-horsepower plant, 160 miles of railroad and extensive shops, employing about 2000 men. The plant is four years old and has been very successful throughout.

I have been given a free hand in operating the plant, the management only demanding that the cost per horsepower per annum be as low as was consistent with proper upkeep.

As coal costs about $6 per ton in Nevada, I have been very keen about anything which would reduce its consumption per indicated horsepower, and so

fell an easy victim to the CO_2-machine man when he appeared.

I was getting an evaporation of 9.40 from and at 212 degrees Fahrenheit with coal which analyzed as follows:

Free carbon, 53.5 per cent.; volatile, 35.5; ash, 4.8; water, 6.2; total, 100 per cent. This gave 12,975 B.t.u. per pound of coal and indicated a boiler efficiency of 70 per cent. Daily records of coal and water were kept, recording thermometers were placed in the hotwell, the heater, the econnomizers and the flues, and I also had recording pressure gages on the stack, the forced draft and the steam header. The CO_2 recorder, seeming to be the final touch required to give complete data on the plant and put me in a position to evaporate the last possible drop of water per pound of coal, I placed a requisition for one forthwith. Three months later the machine arrived, without instructions for assembling, piping or operating. I sent for the instructions, which were received a couple of months later. Then I discovered that some of the ground-glass connections were loose enough to leak and not loose enough to get in any packing, but after some experimenting I found that a mixture of glycerin and litharge would seal the opening and not dissolve under the action of the fluids used in the machine.

Then I found that the rubber tubing was old and leaky. It was replaced. The marking pen was poorly made, and after fooling with it for some time I replaced it with a thin sheet-silver pen which we made at the plant. Next the draft obtained by bypassing the economizer proved too small to pull the gas sample through, and this I corrected by putting in an aspirator worked by compressed air. It then developed that the amount of draft must be regulated within very narrow limits; too much pulling the solution through and too little gave no results at all, this feature causing more trouble than any other one thing about the machine.

Of course, there were incidental occurrences along with these; the cotton thread between the float and counterweight broke twice in the night and resulted in mixing the various solutions; then mud kept getting into the water line and choking up the needle-like jet which furnishes power to operate the recorder. I finally got so I could make the machine work for a few days at a time, then something would happen, which meant a complete readjustment throughout.

I believe that for six months I devoted more attention to the machine than to the rest of the power plant, and in that time I acquired sufficient skill to keep the recorder going for a few days at a time.

As a result of my spending so much time in the fire room I improved the system of firing in vogue, made some improvements in the methods of coal and ash handling, and found some air leaks in the flue system which were cooling the gases passing through the economizer. None of these improvements, however, were due to the records from the machine.

During the periods in which the recorder condescended to record, I would select one battery and experiment with the different methods of firing, keeping track in the meantime of the rate of evaporation per pound of coal. I was by this means able to spot a few of the firemen who were too deliberate in their movements when the fire door was open, but I could not get any relation between boiler efficiency and the percentage of CO_2.

LINDSAY DUNCAN.

McGill, Nev.

Isolated Plant versus Central Station

From time to time I have noticed in the columns of POWER articles, both pro and con, regarding the isolated power plant. After reading these articles I believe that both the arguments in favor of and against the isolated plant have very little real bearing on the subject. It seems to me that this is a matter which must be decided individually, as each existing case has its own characteristic peculiarities which must be considered and which enter largely into its determination.

For instance, in the May 23 issue, Mr. Rushmore cites a case as an example where the isolated plant is a great deal cheaper than buying power from a central station and gives very convincing figures substantiating his claims. One cent per kilowatt-hour is certainly cheap for power from a station of only 350 horsepower rated capacity. He has certain existing conditions, however, such as using part of his producer gas for purposes other than power, which practically preclude all thought of getting power from a central station.

On the other hand, there appears in the same issue, on page 822, an editorial which states that the manager of a certain hotel says "that if he had it to do over again he would install central-station current." The editorial further states that if this manager would pay wages that would insure competent engineers to run his plant, he would have no cause to regret having his own power plant; nevertheless, he is not satisfied with his present installation.

Naturally I do not wish to advance this letter as an argument in favor of the central plant; I merely wish to point out the fact that the isolated plant is not universally the better proposition, although it may be so in a majority of cases.

I had a little experience a few years ago regarding the power question in a small shop of which I had charge, where we gave up generating our own power and secured it from a power company.

When I took charge, the power plant consisted of four gas engines, two of which were rated at 50 horsepower each and the other at 30 and 20 respectively, making a total of 150 horsepower. We used natural gas, getting it from the local gas company. Three of the engines were belted to direct-current generators and the fourth to one of the line shafts on the main floor. This equipment was located in the cellar, was difficult of access, and every spring was subject to considerable water seeping in and damaging the machinery.

We had some ten or twelve motors, all smaller than they should be, scattered throughout the shop to run the machines.

The engineer in charge of all of this equipment was getting $75 per month, plus about $25 for overtime, which he managed to put in on some pretext or other. Questioning this man as to the operations of his engines, etc., he told me that the whole plant was very much run down and sadly in need of a thorough overhauling. I also learned, much to my annoyance, that much time was lost in starting the engines in the morning—we were only running single turn—particularly on Mondays, because of losing over Sunday the air pressure in the receiver tank used in starting up. Often about a dozen men would be in the engine room pulling away at the belts, trying to turn the engines over. In addition, we received regular complaints and threats to move from one or two of our tenants on the upper floors who needed power for light manufacturing.

I lost no time in getting at the problem of better power facilities and, after some figuring on the subject, decided to call in a central-station man and see what he had to offer. He agreed to furnish us power on a sliding-scale basis, similar to that spoken of by Mr. Rushmore in the article mentioned above, at the rate of 2½ cents per kilowatt-hour for the first 6000 kilowatt-hours and 2 cents for all over and above that amount. The minimum charge per month, however, must be $150.

This offer was accepted and we immediately began changing over. I found there were large line losses under the old system so we had the entire building rewired and, as far as practicable, particularly on the larger machines, we installed individual drives.

The system put in was three-phase alternating-current with induction motors. We decided upon this system largely because of the great expense for repairs on the old direct-current motors, this repair work being done by an outside concern.

While this increased the initial cost somewhat, we figured that the estimated saving would justify the expense. We also figured that we would only pay for

the current actually used and instructions were issued to always stop the motor when changing work on the machines, etc.

Our tenants' agreements guaranteed a total minimum power charge of $50, thus reducing ours to $100.

After the new installation was completed, we disposed of the old engines, generators and motors as well as the engineer. Summing up the whole situation, I found that our tenants were perfectly satisfied and that we were getting better power service than ever before, and at no increased cost. We were also able to run one or more machines overtime as our work occasioned, without the necessity of operating a 50-horsepower engine to run a 10-horsepower motor and pay a man in addition to watch the engine.

I do not deny that it might have been possible to fix up the old plant so that we would have had practically as good results, but I doubt that it could have been done as cheaply, and I also doubt that the cost of our power would have been any less. The installation of an entirely new plant, modern in every respect, would undoubtedly have given cheaper power, but with a small concern such a large outlay of money as this would entail is a serious question.

I give this example merely to show that "circumstances alter cases."

EVERARD BROWN.

Pittsburg, Penn.

Writing for the Technical Papers

I quite agree with Joe Smart, whose criticism on my advice to writers is based upon the axiom, "If worth doing at all, do it well." However, there are altogether too many who are deterred from telling us many interesting facts because they are afraid of their ability and of the labor involved in avoiding mistakes in diction and spelling—and fear that the editor will turn them down. If there is a good story in your system, get it out. When you have got the first one out, others will follow more easily. Of course, it would be real nice if each one of us had a typewriter, an Encyclopædia Britannica, and a Century and a Funk & Wagnalls dictionary. But once having seen some of his ideas in print a few times, and found out how nice the water really is, he is a dead one indeed if he is not bitten with the idea to improve himself. It is at this stage of the game that the suggestions outlined by Mr. Smart should be adopted. The main thing is to get the first message out.

Too many good stories die stillborn, because the writer endeavors to make a literary monument of them and is smothered in the mass of detail raised by his own hand, details which do not affect the worth of the idea, but which cause the embryo author to take a course around the block to reach the house next door. I do not deny the value of writing and rewriting; then rewriting and setting the manuscript to one side, perhaps to be entirely rewritten at a later date. I consider this time well spent, but the new writer, the one I am after, has neither the time nor the patience to do this, though later on he will, if ambitious and properly inoculated with the desire to write.

Before one can run he must learn to crawl and then to walk. The best way for the new writer telling his first story is to tell it in the same way he would relate it to one of his mates. If he has a message, the editor will come back at him to get all he has left out. Of course, this takes time, but POWER has found it worth while to do this.

A. D. WILLIAMS.

Cleveland, O.

Belting vs. Electric Transmission

Replying to the communication of Henry D. Jackson, which appeared in the May 2 issue of POWER, I am disappointed, to say the least, that he regards my letter in the issue of March 21 as "taking exception" to his article in the February 14 issue.

A perusal of my letter will, I think, satisfy any impartial reader that the general trend of its subject-matter is in corroboration of Mr. Jackson's exposé of cases where owners of shafting transmission have been "flim flammed" by adopting motor drives.

There is no occasion for commenting on his enlargement and confirmation of several points suggested in my letter. But I do wish to disclaim having attempted to make so thorough an enumeration of advantages of electric drives as to demand designation of a "tabulation of advantages."

As to the additional advantage of motor drives pointed out by Mr. Jackson—that by their use greater uniformity of speed is obtained than by shafting transmission —it is a fact that this is not true in all cases. Occasional drop in voltage and in speed of motors is liable to be experienced with current supplied from the best power plants due to variation in speed of engines or other prime movers, though speed may be corrected more quickly and more easily than with shafting transmission.

The influence which slip of belts has on "production factor," mentioned by Mr. Jackson, cuts a small figure in the average manufacturing plant having properly designed shafting transmission. If speeds are found to fall away from intended ratios, what is easier than to adopt ratios of pulley diameters which will compensate the slip?

One advantage of electric transmission which has not been referred to is that, with or without economy for power, it has wiped out of existence many poorly designed systems of shafting transmission.

Viewed solely from the standpoint of economy for power, the advantages of electric motor drives cannot materialize by the insertion of motors up to the point where the cost of power by shafting transmission balances the cost for power by motor drives. Beyond that point we may confidently look for economy in favor of the motor drive; but no hard-and-fast rules can be laid down to be safely used by tyros in determination of that point. Each proposition for substitution of shafting drive by motor drive, or choice of initial installations, must stand on the merits of conditions, and for successful determination the conditions require intelligent and disinterested engineering analysis.

Average American manufacturers pride themselves on their alertness in adopting improvements that are conducive to economy, but when it comes to inaugurating improvements they are seldom moved to engage advice beyond their own organization. It is not until mistakes have become unendurable that they are brought to realize that something different might have been.

FRANKLIN VAN WINKLE.

Paterson, N. J.

The Need of License Laws

There have appeared in recent issues of POWER several articles on how the average engineer might better his condition and fit himself for promotion. I hearily agree with the suggestion that each State or city adopt license laws. If an engineer were compelled by law to satisfactorily discharge his duties, many of the accidents occurring today would be avoided. During a visit to a small country town a saw and cider mill, which also boasted of a small grist mill, came under my observation. There was a small slide-valve engine, about 10x22 inches, running, or trying to run, at about 120 revolutions per minute. While examining the engine I was accosted by the engineer, who was also the owner, the sawyer and the mill operator. Upon learning that I was an engineer he proceeded to enlighten me regarding his experience, to the edification of several spectators, as follows:

"So you be an engineer, be ye? Wal, what dy'e think of that fer an ingine! Never laid out a dollar on her in 15 years. No, siree; never had the cylinder head off. The feller that fixer her up fer me told me not to let anybody monkey with her but myself, and, b'gosh, I ain't either, and she's better'n she ever was.". I remarked that she must be a pretty good engine to run that length of

time without any repairs. "Wal, the feller that fixed her up was a mighty good mechanic, but he did have a job to rig her. Yer see, when ther ingine first come here ther blamed stuff that goes in the cylinder was all broke ter pieces and was sent in a pail. That feller had some job fixing them pieces together. He said he had to buy a bigger biler as ther old thing was leaky and didn't hold steam enough."

I said that probably the piston was down and that steam might be blowing through to the exhaust.

He replied: "No, siree; how in thunder could the piston get down? It was a tight fit after the feller had got all ther pieces together, for he had wired them all up. As he hadn't taken ther cylinder head off how in thunder could ther durned thing cum down?"

As I watched him he prepared to saw a log, having obtained the necessary steam. As soon as the log approached the old engine slowed up badly.

He explained this by saying that, "Ther governor took some little time to git a hold on her; she didn't always work that way."

Let those who oppose the passing of a license law visit such a plant as the above and I am confident they will cease their opposition.

Bridgeport, Conn. H. TAYLOR.

Piston Rings

In Lloyd V. Beets' article on packing rings in the May 2 number, Mr. Handley's sketch showing side plates fastened on the ring lap with small screws is a poor apology for a joint and there is not much merit in the lap joint offered by Mr. Beets. I have had these same joints

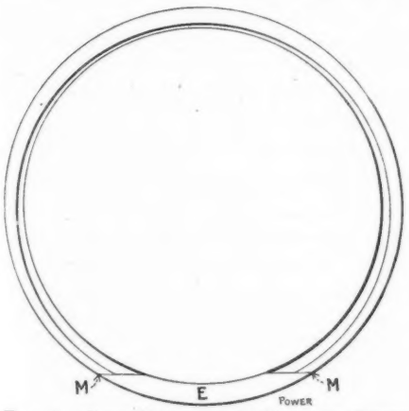


FIG. 1. ONE METHOD OF MAKING TIGHT PISTON

to contend with in practice, both to repair and to replace, and the small screw that holds this lap in place can never be kept tight. The only way to make this joint secure is by using rivets of bronze or copper. The small springs will not stay in place for long, and when they come off will cut the cylinder or the side plates. Both constructions from a practical point of view are useless and unsafe.

Fig. 1 shows one of the better ways of making a tight piston, the block *E* at the bottom of the piston being simply a section turned to fill the groove. With a well formed ring making a joint at *M* on either side there will be no doubt about making a satisfactory job. I have seen this type of ring give satisfactory service after being in constant daily use for a period of 10 to 12 years. The tension of the ring keeps the joints in contact until the ring has been completely worn out.

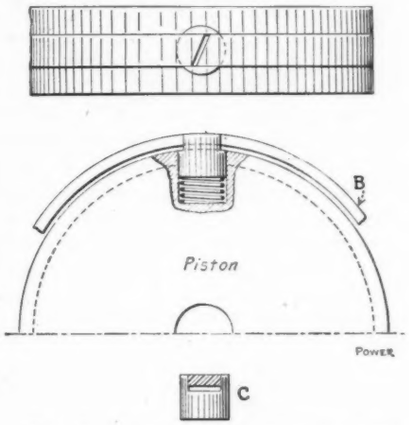


FIG. 2. PLUG AND SPRING METHOD

Fig. 2 shows another method of making a good ring joint. A bronze plug is sunk into the ring groove, as shown, with a heavy spring beneath it to set it out. As the spring is placed beneath the plug, there is no chance for it to break and damage the cylinder. A ring fitted to the groove, with a dowel on the side so that the ring will not turn too far, will insure a good tight piston. The ring is shown set out of place at *B* in Fig. 2 and a cross-section of the ring at *C*.

C. R. MCGAHEY.

Baltimore, Md.

Return System

In the April 18 number, page 610, William Bopp asks if the drips from the steam main, separators, reheating coils and four engines which are collected in a manifold in the basement 20 feet below the boiler water line, and having 10.5 pounds pressure loss, can be returned to the boiler by the Holly system.

The condensation in this manifold may be returned by a Holly system, of which the discharge chamber has a vertical hight of 42 feet from its bottom end above the boiler water line, the diameter of the riser and other pipes to be determined by the size of the job, of which no mention is made. The average Holly receiver is 30 feet below the boiler water line, and many of them are 50 feet or more.

RUSSELL B. HOBSON.

New York City.

Test for Valve Leakage

In answer to S. Kirlin's article in the issue of April 25 referring to the high steam consumption of a four-valve engine, I would suggest that if he close the steam and exhaust valves, open the indicator cocks and the throttle, he will see a display of high-pressure steam that will explain to his entire satisfaction that the cause of the high-steam consumption of this engine is not the long drip pipe but leaky valves.

Many engineers will no doubt be surprised to learn that the loss due to valve leakage amounts, in many cases, to 50 per cent. or more of the steam used.

O. H. LUDEMAN.

New York City.

Central Station Failure

The failure of central-station service due to fire or other acts of Providence certainly furnishes a strong argument in favor of the isolated plant.

Such an instance occurred recently in the central district of Philadelphia when an early morning fire damaged the plant to the extent of about $20,000 and interrupted the service for several days. While the actual fire damage was comparatively small, it resulted in temporarily putting the entire plant out of commission and in causing unmeasureable inconvenience to its consumers.

As the result of this failure of service many small manufacturers were unable to operate their machines and had to dismiss their employees. In some of the large office buildings it was impossible to run the elevators and many business men and clerks had an enforced holiday. In some of the large stores the loss of power for elevator and for lighting service made it necessary to suspend business. This caused a loss of about $250,000 in sales alone.

These few instances serve to show the large financial loss that manufacturers, mechanics, business men and merchants may suffer through getting their service from a central station. It now remains to be seen whether they will profit by their experience.

In abandoning their isolated plants users of power overlook the possibility of such a contingency as cited above, and which to their sorrow they have found to be vital. Possibly, if they take advantage of the Philadelphia consumers' experience, overhaul their power plants and secure the services of an efficient engineer at a suitable salary, they may be surprised to find that not only are continuity of service and independence secured, but that there is also a saving in the cost of power. Such a result is not impossible.

G. WISE.

Philadelphia, Penn.

Inquiries of General Interest

Questions are not answered unless accompanied by the name and address of the inquirer. This page is for you when stuck—use it

Effect of Eccentric Advance

What effect has increasing the angle of advance of a plain slide-valve engine eccentric on the amount of port opening?

C. N. M.

It does not affect the port opening because it does not change the valve travel. The effect of angular advance of the eccentric is to bring all of the events earlier in the stroke. Lead and compression are increased and release and cutoff hastened.

Momentum of Railway Train

A railroad train weighs 600,000 pounds and is running on a level track at the rate of 45 miles per hour. Suppose the steam shut off and no brakes applied. How far will it run before coming to rest?

J. McC. C.

The train velocity in feet per second would be

$$\frac{45 \times 5280}{3600} = 66 \text{ feet}$$

The energy stored in the train would be

$$\frac{WV^2}{2g} = \frac{600{,}000 \times 66^2}{2 \times 32.16} = 40{,}634{,}328 \text{ foot-pounds}$$

The sum of the products of the average resistances into the distances through which they are overcome must equal this number. Each axle bearing, for example, has a certain resistance to turning which depends upon the weight it carries, its diameter, its condition as to smoothness, temperature, lubrication, etc. This resistance measured in pounds applied at the radius of the bearing and multiplied by the number of feet through which a point on the surface of the bearing would travel would be the number of foot-pounds absorbed by this particular bearing. Then there is the rolling friction of the wheels on the track, the friction of the engine pistons, valves and connections and the windage, a very important resistance when the speed is high and diminishing as the speed increases.

The subject of train resistance is a complex one and not enough is known about it to solve the present problem with the information given.

Opening of Drain Cocks

Should the drain cocks on the cylinders of a duplex pump be open when starting up?

E. S. H.

Drain cocks are provided on steam cylinders for the purpose of drawing off any condensation that may interefere with the proper action of the machine. While no material damage may result from the starting of a direct-acting steam pump, as would be in the case of an engine, the pump will start more easily and more quickly with steam than with water. Some engineers allow the drain cocks on steam pumps at the end of long steam lines to blow a little all the time to make sure that water does not accumulate in the cylinders and make the pump action irregular.

Alternating-current Generator and Motor Speeds

Does the speed of an alternating-current generator affect the speed of an induction motor taking current from its circuit?

H. E.

Yes; the speed of the motor is directly proportional to the frequency, under any given set of operating conditions, and the frequency is determined by the generator speed.

Transformers

How many kinds of transformers are there?

H. E.

That depends on what you mean by "kind." There are single-phase and three-phase transformers; also constant-potential and constant-current transformers. Any of these may be of either the core type or the shell type. Read Mr. Meade's article in the issue of March 29, last year.

Effect of Pulley Coverings

Does covering a pulley increase its efficiency? Is canvas a suitable covering? What kind of cement is used to hold it? Can a steel pulley be covered as effectively as a wooden one?

E. L. D.

Pulley coverings increase the friction of the belt; consequently the power that may be transmitted is also increased. Canvas is frequently used and is secured by glue. Steel and iron pulleys may be as readily covered as wooden pulleys if the metal is cleaned and painted.

Object of Two Eccentrics

What is the object in placing two eccentrics on Corliss engines?

O. T. E.

An additional eccentric was first put on Corliss engines for the purpose of getting an early opening of the exhaust valves without reducing the range of cutoff. Incidentally, it is used to provide for a range of cutoff beyond half stroke.

Water and Oil in Compressed Air

We have been experiencing trouble from water coming through with the air from our compressor. Sometimes small particles of oil will pass. The air, as it leaves the compressor, is warm and it occurs that if this air were cooled to a point lower than it would again become and drained at the point of lowest temperature, that it would not again form water.

O. J. B.

An aftercooler, as it is called, built something after the manner of a closed feed-water heater, or a surface condenser, will lower the temperature to a point where most of the water will separate from the air. From the aftercooler the air should go to a large receiver with inlet at the top and outlet about half way up on one side. Here the remaining water and oil will fall to the bottom and may be drawn off.

Curing Premature Ignition

A single-acting gas engine runs smoothly at light loads but thumps badly from premature ignition when fully loaded. The compression can be changed by screwing the piston rod into or out of the crosshead block; will that help matters?

E. B.

Possibly, reducing the compression by screwing the piston rod into the block one or two threads may cure the trouble. It is possible, however, that your ignition is advanced too far for full-load conditions. Better try adjusting the ignition for less advance before you make any such fundamental change as altering the compression. Also examine your exhaust gas and see if it is black and sooty; if it is, the premature ignition is due to too rich a mixture.

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A Heating and Ventilation Department

For some time there has been a demand for a heating and ventilation department. We have, of course, published articles on these subjects from time to time, but there has never been a definite location in the paper to which readers interested in such matters could turn and find all the material contained in any one issue.

Beginning with this issue the new department will alternate with the refrigeration department, therefore appearing every other week. Material such as will be useful to the practical operating engineer is specially solicited, although some consideration of the fundamental underlying principles and directions for figuring the amount of heating surface required, the amount of boiler surface necessary to supply it, etc., will not be out of place.

"Old Sol" will, of course, deliver all the heat that is necessary for the present, but now is the time to get the system in shape for next fall. Tell the other fellow the troubles you have had and what you are doing to overcome them. We need this kind of material to make the department a success.

The Central Station Viewpoint

The article on "Analysis of Industrial Power," which appears elsewhere in this issue, is representative of the central-station point of view. Undoubtedly, in many small plants the cost of power is figured without due regard to the fixed charges; items of interest, depreciation, and obsolescence are ignored, and as a result the apparent cost represents the operating expense only.

All items which legitimately belong to the fixed charges should be included; but, as a rule, the central-station advocates are not content to play the game fair, and insist upon burdening the isolated plant with all sorts of fictitious charges. These tactics are employed in order to offset the enormous overhead and distribution charges which the central station is forced to carry. The isolated plant does not have to pay a franchise tax; it does not have to pay high-salaried officials nor expert solicitors for canvassing new business; and it is not burdened with the initial cost and upkeep of an elaborate distribution system.

According to the reports of the Public Service Commission, the actual operating expense of a large central station in New York City forms only twenty-six and one-half per cent. of the total cost of production, the remaining seventy-three and one-half per cent. being made up of overhead and distribution charges. Furthermore, this same company is capitalized at over four hundred and forty dollars per kilowatt of rated capacity. Considering that a small uptodate plant may be installed for about one hundred dollars per kilowatt capacity, the comparison is striking. In view of the foregoing, it would make interesting figures if some of the arguments of the central-station people were applied to their own plants.

Reverting to the previously mentioned article, a statement will be found to the effect that tenants in a building are obliged to pay a *pro rata* share of the plant investment and other fixed charges; hence, when comparison is to be made between two similar plants only the operating costs need be considered. Granting this, why should the plant be charged again with these fixed items of expense when comparison is to be made with central-station service? Surely the tenants' rent is not reduced.

Furthermore, it is contended that a plant should show a return upon the capital invested equal to that of the average manufacturing business. This is the "marginal principle" upon which we have expressed opinions on several occasions. It will suffice to say that this principle is applicable only when a man is at the limit of his credit.

In Table 1, which represents a report for an isolated plant using exhaust steam for heating, provision is made for the time and thought given to the management of the plant by the superintendent. In Table 2, however, which represents a report covering a case where power is purchased from a central station and a separate heating plant is installed, the superintendence item is omitted. It would seem that the supplies and operation in the second case would require nearly as much of the superintendent's time as in the first case.

Again, it is claimed that the presence of a power plant materially increases the insurance risk on the rest of the building. This contention is groundless, for

where the requirements of the building laws and the Fire Underwriters' Code are met, it has no effect upon the rest of the establishment.

Perhaps the most absurd contention of all is that which refers to the loss of output due to a variation in voltage in the case of the isolated plant, and a consequent charge against the plant to cover this loss. While it is true that few small plants are equipped with voltage regulators, still, with a good engine governor and a watchful attendant the voltage should be kept within two or three per cent. If it varies as much as five per cent. there is something wrong with the equipment or the method of operation, but the isolated plants as a class should not be held accountable.

Where there are a number of customers supplied from a central station by a feeder of considerable length, it is impossible for them all to receive current at the same voltage. If the regulation at the switchboard is effected so as to supply those nearest the power house at the specified voltage, those at the end of the line suffer, and *vice versa*. In any event, there is a significant drop in voltage which is apt to be greater than that in the average isolated plant.

As there are two sides to every argument it is only fair that both the central-station and the isolated-plant advocates be heard. However, the intelligent engineer or superintendent will not be misled by unreasonable claims of either side but will select the sound arguments and formulate his opinions thereon.

Ignorant or Careless?

One State and one municipality have this year taken steps forward in the matters of engineers' licenses and boiler-inspection legislation. On the other hand, bills providing for such supervision have been turned down by the legislatures of Colorado, Connecticut, Indiana, Iowa, Maine, New Hampshire, New Jersey, New York, Oregon, Pennsylvania and Rhode Island. Just why such reactionary and unsound views should be held by the legislators of these States is not clear.

We have been reliably informed that since the creation of the Board of Boiler Rules by the legislature of Massachusetts, there have been installed in New Hampshire, Connecticut and Rhode Island boilers that have been forbidden entry and installation in Massachusetts because they were manifestly unsafe for power-plant purposes.

By what mental process a Connecticut law maker arrives at the conclusion that a boiler which is unsafe in Massachusetts is safe in his own State is not easily imagined. Why a New Hampshire legislator is willing to have his State called the dumping ground for worn-out Massachusetts boilers or is opposed to having it known as a commonwealth where some regard is paid to the common safety of its people is also very obscure. In fact, it is incomprehensible that any class of men could be so completely forgetful of the duty they owe to society as to deliberately sidetrack or kill any proposed measure to enhance public safety.

It is not to be expected that legislators should know all about these things without being shown, but it would seem that the most ordinary degree of intelligence and common regard for human life would prompt them to investigate the merits and meaning of measures of the kind under discussion before condemning them. It is assumed that legislators have ordinary intelligence; if this assumption is justified, then some of them evidently do not care anything for the hazard to life and property represented by an uninspected or improperly operated steam boiler.

Opportunities for Self Advancement

There has never been a time when the young man had more or better opportunities for self-advancement than at present. Few consider the strides that have been made within the last twenty-five years or that will be made in the future. Each succeeding generation of young men holds the mistaken idea that the day of opportunity and possibilities to succeed belongs to the past. They lose sight of the fact that success is attained by earnest, hard work.

Looking back twenty-five years, many of us can remember when a boiler carrying one hundred pounds pressure of steam per square inch was out of the ordinary. Men saw the need of high steam pressure and boilers were designed to meet the requirements.

It is but a few years ago that the electric light was in the experimental stage and the electrically propelled street car was unknown. But the opportunity was at hand and as a result artificial daylight has been obtained and street cars are counted by thousands.

The gasolene engine is another instance. The possibilities of this type of prime mover were made apparent, and from the once unreliable unit used to run a wood saw, gasolene engines are now built in capacities ranging as high as 5400 horsepower.

So fast have been the developments along mechanical and scientific lines that we take a new discovery or invention as a matter of course, exclaim "What next?" and go on with our work. Men pay the toll for a wireless message much the same as they would for a shoe shine, and seldom consider the thought and energy which have been expanded in perfecting the wireless apparatus.

An engineer may say, "I am not an inventor." He does not invent, it is true, but every engineer can discover some method whereby power can be developed cheaper than under old conditions.

Every man has his opportunity. Some profit by it, others do not see it at all and others think it is not worth while.

One thing to remember is that when the chief engineer of a plant wants an assistant he will not select the man who has not shown that he has qualifications for filling the position.

Every chief has his eye on his subordinate, and unless the man can show that he is capable and willing, has original ideas and exercises them, besides having a practical knowledge pertaining to his work, he cannot expect that he will be the fortunate candidate for advancement.

It is not a bad idea to learn to work, but one cannot do that while looking at the clock with one eye and for Saturday night with the other. One of the mistakes made is to assume that a certain work is beneath one's dignity. The successful men are those who have formed the habit of doing the best they know how, no matter what task has been given them. A capable workman will not be asked to do the common work after he has shown his worth. Giving a dollar's worth of work for eighty cents' worth of wage is a practice that leads to ultimate success. It is the man who fears he will give more than he receives who fails to see the opportunities as they appear.

There are opportunities before you now. They will be before you tomorrow. Wake up and make use of some of them.

In all phases of the steam engineer's vocation there are efforts and resultant achievements and the intensity and intelligence of the efforts determine the value of the achievements. Perfunctory, half-hearted effort never "gets anywhere"; neither does ignorant groping around, however vigorous.

Have you noticed how some men neglect the oil supply and then wonder why that bearing ran hot?

Have you ever noticed how overbearing some chiefs are with the firemen and ashmen?

Recording instruments in a power plant are valuable instruments, but if you do not know how to read and handle them they might just as well be in the other man's plant.

Leakage past a solid plug or piston valve is a hard matter to determine, but that there is leakage is well known. The amount depends on many things; probably the first is the quality of the material of which the engine was built; the second, possibly, the accuracy with which the engine was built; and, thirdly, the care with which the engine is handled.—*The Engineer.*

Heating and Ventilation

Considered as power plant problems. Layout and operation of systems and apparatus

The National District Heating Association

The third annual convention of the National District Heating Association was held at Pittsburg, Penn., on June 6, 7 and 8. The sessions were held in the banquet hall of the Fort Pitt hotel, the first being called to order at two o'clock on Tuesday afternoon, when President George W. Wright, of Baltimore, presented his annual address and the association was welcomed to the city by representatives of the mayor and the Chamber of Commerce. E. J. Keifer, of Easton, Penn., presented a progress report of the committee on data and the committee was continued to complete its work, which has been largely preparatory.

At this and subsequent sessions the following papers were presented, several of which with their discussions will be treated at length in other columns and issues: "Investigation of the Transmission of Heat through Radiating Surfaces," by Prof. John R. Allen; "Heating Franchises," by A. C. Gillham; "Results of Measuring Station Load by Venturi and General Electric Meters," by F. C. Chambers; "The Heating and Ventilating Equipments of the City Investing Building, New York City," by J. Byers Holbrook; "The Preparation of a Rational Rate System," by R. D. De Wolf; "Superheated Steam," by W. E. Dowd, Jr.; "Handling Customers," by George W. Wright; "Best Systems of Radiation for Economy and Steam Consumption When Fed from a District Heating Station," by Walter J. Kline; same for hot water, by A. C. Rogers.

On Tuesday evening the delegates and visitors were entertained at the Grand theater. On Wednesday afternoon they were taken to the Westinghouse shops, and in the evening a reception was given upon the roof of the Oliver building, which was handsomely illuminated and decorated for the occasion. On Friday they were the guests of the National Tube Company at its McKeesport works.

The election resulted in the choice of the following officers for the ensuing year: A. D. Spencer, Detroit, president; W. Patridge, Springfield, Ill., first vice-president; R. D. De Wolf, Rochester, N. Y., second vice-president; Cadwalder Evans, Jr., Pittsburg, third vice-president; D. L. Gaskill, Greenville, O., secretary-treasurer; E. J. Keifer, Easton, Penn., and J. L. Hecht, Chicago, executive committee.

The next place of meeting is fixed by the executive committee, but Chicago was favorably considered.

Hot Water Heating Systems and Methods of Connection to a District Heating System*

By A. C. Rogers

To illustrate this paper a number of diagrammatic sketches have been made in isometric to show to better advantage the different systems of piping, but before describing each illustration, it might be well to state that district hot-water heating is a forced feed and that the best results and greatest economy come from maintaining a gravity flow and outflow to all radiators. By reason of this forced feed all heating systems are very sensitive, some more than others, but as a class very much more than a regular gravity heating system.

A general supervision of house installations when connected to district heating is incumbent upon the engineering department of the heating company. This holds good for hot water as well as steam heating and is largely practised by all companies. In new work this may be easily accomplished, but when contemplating heating systems already installed and being locally heated the engineer may expect to meet difficulties both in the system and with the owner. An owner may be indifferent to results and economy when running his own heating plant and yet may be very exacting when getting service from a district company. The engineer often meets with systems that cause him to wonder how heating was ever thought of or accomplished.

Fig. 1 illustrates a single-belt one-pipe hot-water gravity system which was used more some years ago than now, although when properly laid out and installed gives very good results. The feed of all radiators is taken off at the top of the main and the return enters the side of the main. In this system there is a gradual drop in temperature as the water flows along the main, due to the cooled water in the radiators dumping back into the main, and the radiators must be figured for this drop to give the results desired. The method of adjusting for district heating in this case is as follows: The boiler is cut out by putting valves in the flow and return pipes or blank flanges or blind gaskets in flange unions as at *E F*, the expansion tank is cut off by a valve or by capping or plugging the leads to it; the service is cut in by tapping the main at *J* and *K*. Service valves *G* are always put on the service inside of the building wall and the regulating valve *H* is placed on the service return pipe just before leaving the building; by proper adjustment of *H* the results are fully up to all that was ever accomplished by local heating if not better.

In Fig. 2 a system the same as Fig. 1 is illustrated except the system has two belts and in addition to the instructions for Fig. 1 the return has two connections, and regulating cocks *M* are installed on both returns and adjusted to equalize both belts, preventing a short-circuit in either belt and giving an equal distribution.

Fig. 3 is an illustration of the well known two-pipe underfeed gravity system, and the following method is given: Blank off the boiler at the feed and the return and also the expansion tank; tap the feed service in at the boiler as at *J* and tap the return in at the extreme end of the return main away from the boiler as at *K;* this method prevents short-circuiting and promotes a balancing that is otherwise troublesome.

A single-belt two-pipe underfeed gravity system with parallel mains but opposing flow is shown in Fig. 4. The writer would place this system at the head of all underfeed work. The mains of themselves will practically make a balance to the job, and a building, even though quite large, with clearance for the mains can be accommodated on one belt. This system will work by gravity without any pitch to the mains providing the size of the mains is liberal. The method of connecting to the district heating may be readily outlined.

Fig. 5 is a sketch of only a portion of a multiple underfeed system, only the

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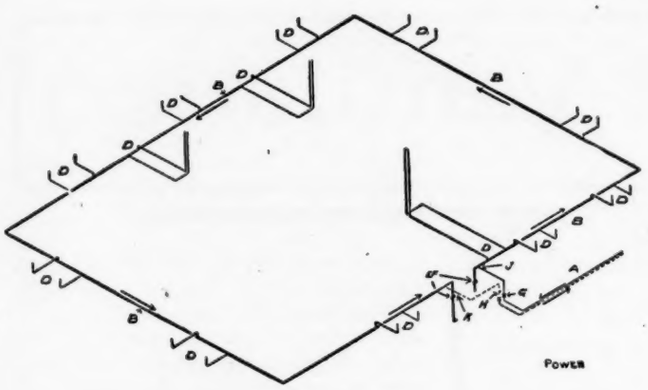


Fig.1

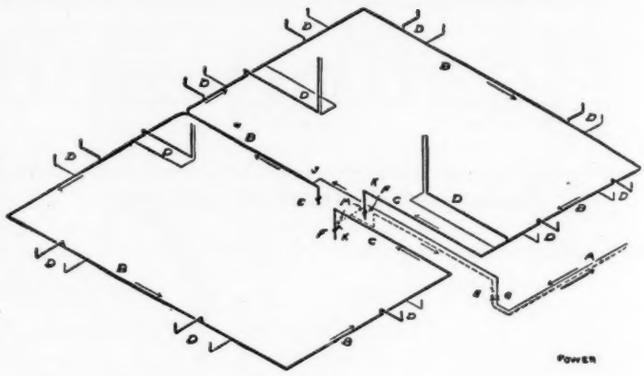


Fig.2

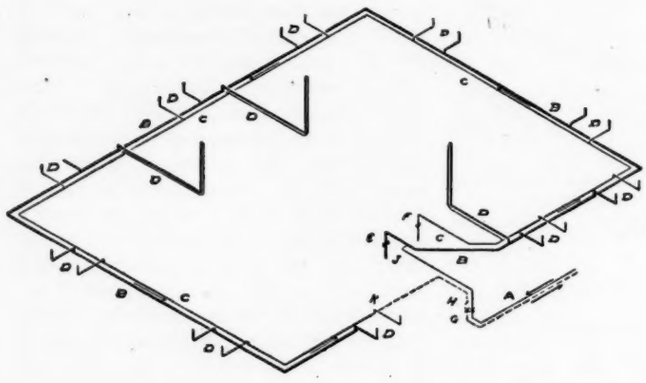


Fig.3

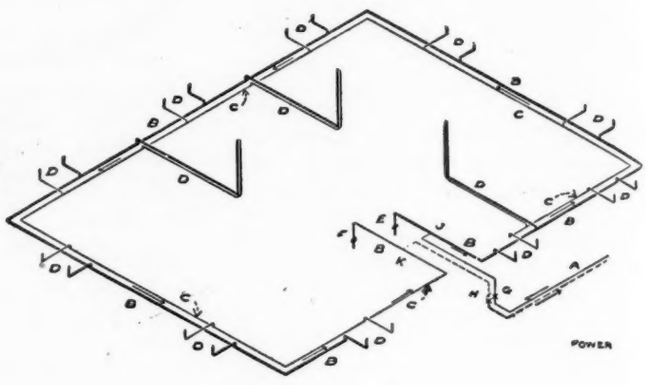


Fig.4

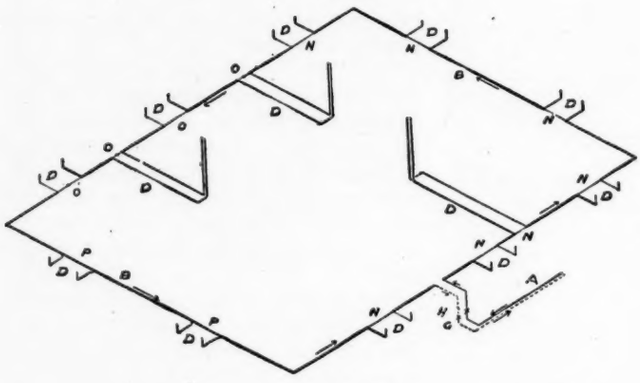


Fig.6

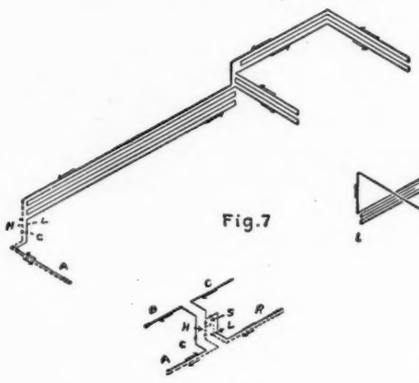


Fig.7

Fig.8

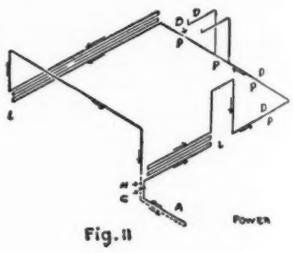


Fig.11

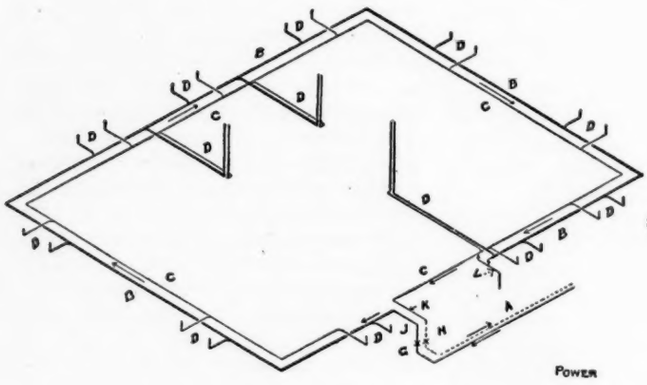


Fig.9

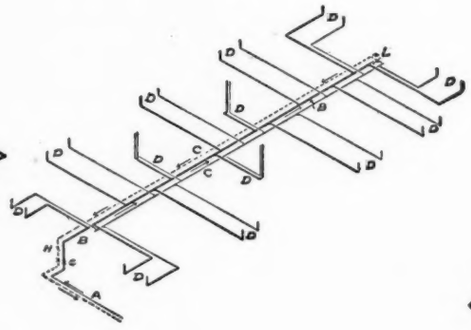


Fig.10

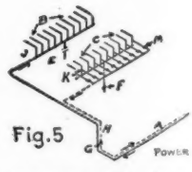


Fig.5

A—Heating company's service pipes into building.
B—House system feed main or flow pipe.
C—House system return main.
D—Radiator supply and return branches.
E—Valve or blank flange on boiler feed to flow main.
F—Valve or blank flange on return pipe to main.
G—Service valves on district supply service inside building wall.
H—Heating company's regulating valve on return pipe of service.
J—Connection of service flow into *B*.
K—Connection of service return into *C*.
L—Drip or drain connections.
M—Regulating cock or valve on return branches.
N—Small pipe bypass in system, Fig. 6.
O—Disk or regulating cock bypass in system, Fig. 8.
P—Bypass of full pipe with radiator branches taken off with y's or branch tees.
R—Secondary garage service.
S—Bypass with customary three valves to form it.

headers being shown. When this work is encountered the following connections are made: Tap the main flow header at *J* and tap each return marked *C* at *K*, installing a cock *M* for regulation on each unit; the boiler is blanked off as before at *E* and *F;* by adjusting *M* with an opening in each to suit the duty a balance is made and short-circuiting prevented.

Fig. 6 is a one-pipe forced-feed series system for district work only. The sketch shows first a small pipe bypass *N;* the pipe being smaller than the main favors a flow through the radiator; next a bypass with a cock for adjustment or a union with a disk with a hole of proper size, shown at *O;* and next a full bypass as at *P* with branches taken off with *Y* fittings or branch tees; there are some places, as in Fig. 11, where this is the only arrangement possible, but for house or residence work this system is not now allowed.

Fig. 7 shows a forced-feed heating coil, such as for factory and garage work; the feed is connected to the bottom of the coil and the return is taken out at the top; by this method a full pipe is assured and the coil is self-freeing of air, all air being driven out and no air vents being needed; the sketch shows a coil running along the wall with a right-angled branch and a continuation through to another room; headers cannot be used in this work on account of short-circuits and a return-bend coil is used; where a header coil is met with disks or cocks for regulation in each coil of pipes are necessary.

Fig. 8 shows a method of supplying a garage after heating a residence; the garage service is shown and marked *R*, this system being cut in the return pipe only and for control a bypass *S* with three valves is installed; by this method the garage is fed when wanted and otherwise cut out; when the garage is on, regulator *H* is opened for larger feed and good results are obtained.

The standard two-pipe pressure-gravity system which is locally called "double belt" and is the system most generally used, is shown in Fig. 9; it gives perfect results, is low in friction and balances up with no drawbacks; it is very sensitive though and a trap in a radiator branch is fatal to that radiator; this belt on, say, 20x30 feet can supply 1200 feet of radiation with ample results; larger belts are made in 2-inch and 2½-inch plate sizes. Fig. 10 shows the same system for locations where the radiators are placed in a narrow zone; it is a three-pipe belt and gives good results.

Fig. 11, a system installed in a large garage, is a series-pipe job with radiators and coils both. A radiator located on the floor above is shown. The front of the garage having large doors and also a side door with cement floor causes the belt to be carried over the opening; traps are thus formed and while not detrimental to heating with this job, yet for safety when the system is shut off drips are placed on all low points.

Two other systems should be mentioned. In both the feed is carried to the top of the building and fed downward, the return being in the basement. The runs of the mains are similar but the branches for the radiators are different. In the first a single pipe making a vertical series is used in which all radiators on that branch are in series. In the other the radiator branches are fed in multiple and the feed supplies all radiators, while a separate return pipe carries the cooled water from the radiators. Both can be used on pressure work, but the writer would strongly urge the last system for both gravity and pressure work. These overhead systems are recommended for buildings of more than three stories high and where attic room can accommodate the main.

An Improved Heating System

By V. T. Kropidlowski

I have been experimenting considerably on our heating system, and have finally got it as I think it ought to be to give good service.

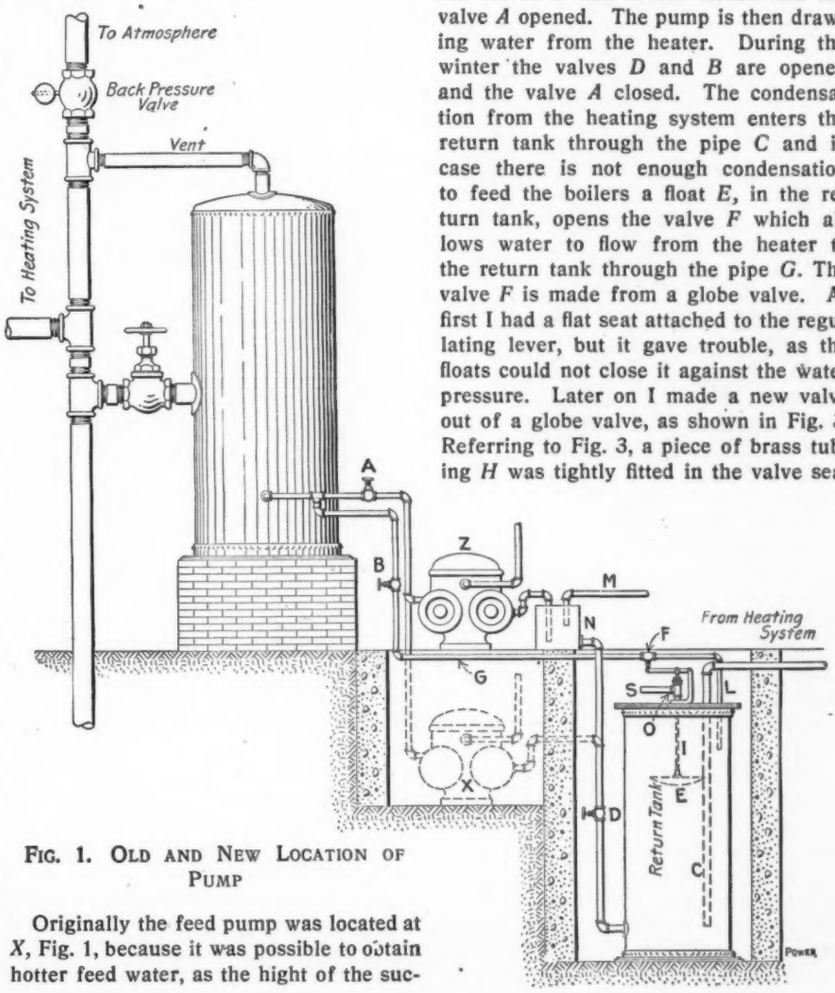


Fig. 1. Old and New Location of Pump

Originally the feed pump was located at *X*, Fig. 1, because it was possible to obtain hotter feed water, as the hight of the suction lift was reduced to a minimum. It was soon found, however, that there was still vapor enough to break the vacuum. The pump needed frequent repairs and, as the pit was rather small, the pump was placed as shown at *Z*.

To overcome the vapor trouble I found a small air-tight vessel *N* to use as an air reservoir and connected it up as shown. *M* is the cold-water injector, shown in detail in Fig. 2, which is self-explanatory.

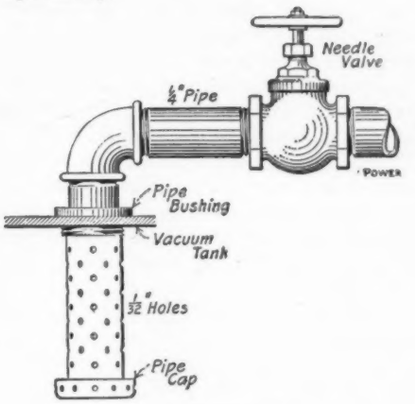


Fig. 2. Details of Strainer

The system is operated as follows: In the summer when no heating is done, the valves *D* and *B* are closed and the valve *A* opened. The pump is then drawing water from the heater. During the winter the valves *D* and *B* are opened and the valve *A* closed. The condensation from the heating system enters the return tank through the pipe *C* and in case there is not enough condensation to feed the boilers a float *E*, in the return tank, opens the valve *F* which allows water to flow from the heater to the return tank through the pipe *G*. The valve *F* is made from a globe valve. At first I had a flat seat attached to the regulating lever, but it gave trouble, as the floats could not close it against the water pressure. Later on I made a new valve out of a globe valve, as shown in Fig. 3. Referring to Fig. 3, a piece of brass tubing *H* was tightly fitted in the valve seat

and a brass plunger *J* was turned to the form shown and fitted to the brass tubing so as to work freely. The holes *K* and *L* were drilled at a proper location and the stem screwed into the plunger.

Water enters the port *M*, in the plunger, and the water finds its way through the holes *L* into the space *W*, which surrounds the plunger, and exerts its pressure upon the plunger both ways, and thus keeps the plunger in balance. The float has only the weight of the plunger and lever to lift. When the water in the tank gets below its level the float pulls down on the plunger until it passes by the holes *K*, when the water from the heater will pass to the tank through the passage *M* and holes *L* and *K*.

The arrangement at *O*, Fig. 1, is made as shown in Fig. 4 and needs no explanation other than that a brass packing nut *P* has been made and screwed into the pipe bushing, as vapor arising from the tank was a nuisance.

The floats had to be made in sections, because the tank had already been made with the heads riveted on and only a 5-inch hole in one head.

Fig. 4 will give an idea as to how the floats were made. Five of the floats were connected together with a rod after placing them, through the 5-inch hole in the tank, after which the stem *R* was connected to the float lever.

Referring again to Fig. 1, *S* is an overflow to the sewer in case the floats get

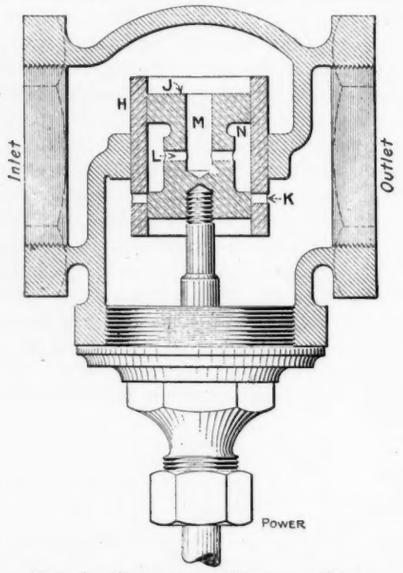


FIG. 3. SECTIONAL VIEW OF VALVE

stuck or something else happened to flood the tank. Fig. 4 shows how the sewer communication was attached to the tank.

I found it necessary to put in a needle valve for regulating the injection water as, with a globe valve, I could not get a fine enough adjustment and there was a loss of heat due to an excessive amount of injection water. The finer the water can be sprayed the better, as it then takes less water to keep the vapor down, and, consequently, less heat is extracted.

With this arrangement I can feed the water to the boilers at a temperature of 198 degrees. If another pump were available the water could be pumped from the return tank into the heater and the water heated to about 210 degrees. I was convinced, however, that the cost of an extra pump and the steam it would

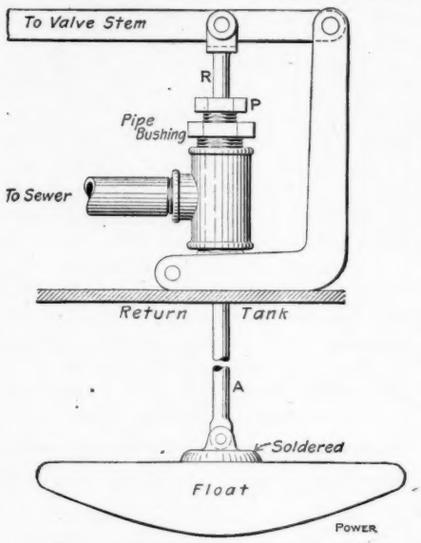


FIG. 4. DETAILS OF THE FLOAT

consume would cause a greater loss than the cost of the coal it would take to furnish the difference of heat units between 198 and 210 degrees.

Running Condensing on the Heating System

An interesting experiment has recently been made at the First National Bank building, Chicago, in utilizing the heating system of the building as a surface condenser during nights and Sundays, when the heating requirements were not severe but when, nevertheless, electrical current must be furnished 24 hours a day.

It is obvious that this arrangement can only be used when the heating system is partially filled with steam. In practice it has been used when the temperature of the outside air ranged from 40 to 60 degrees and it is estimated that during the months of March, April, October and November conditions will be favorable for its operation.

The heating system is an ordinary Webster installation, controlled by thermostatic valves operated by compressed air, and the method of proceedure is merely to shut off the compressed-air control, which has the effect of opening all the radiator valves of the building to the exhaust. The vacuum pumps then pull a vacuum of 12 to 21 inches through to the engines.

The accompanying curves show the coal consumption and kilowatt-hour load for the month of March. The experiment was not started until March 11 and it is easy to note on the curves what the effect has been.

On March 9 with a load of 2400 kilowatts the coal consumption was 38 tons. On the next Sunday with the heating system used as a condenser and a load of 2200 kilowatts, the coal consumption dropped to 26 tons, showing a saving of twelve tons for the day with practically the same electrical load.

It will be noted that on the following two Sundays the conditions were practically the same, each showing a saving of approximately twelve tons of coal over that obtained before the change was made.

Another point is worthy of remark. On March 6 with an electrical load of 6600 kilowatts the coal consumption was 49 tons, while on March 19 the heaviest peak of the month, 7000 kilowatts, was carried on a coal consumption of only 44 tons. This shows in a striking manner the economical effect of the arrangement.

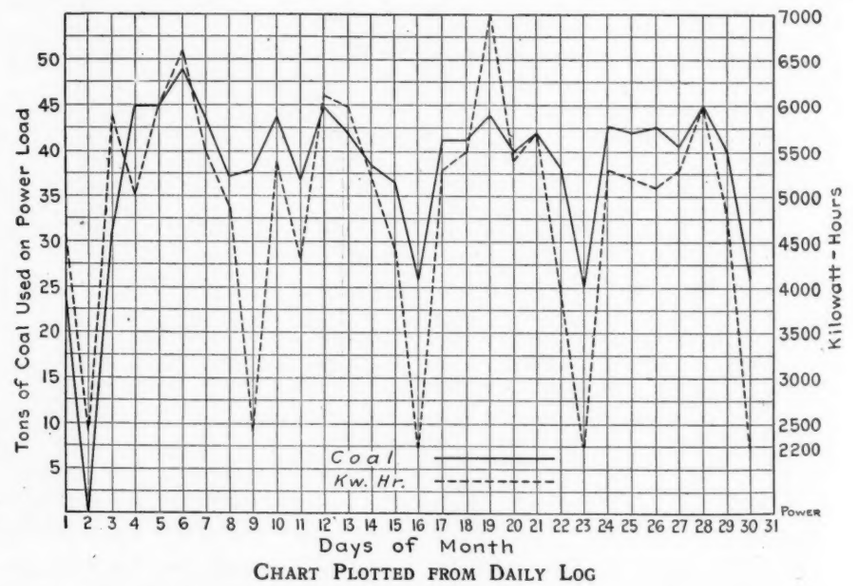


CHART PLOTTED FROM DAILY LOG

Reciprocating Blowing Engines*

By W. Trinks

By increasing the piston speed of the blowing engine to that of the power gas engine or the power steam engine, the first cost of the reciprocating blower is reduced. Standard types of American blowing engines, although satisfactory at low piston speeds, have not, as a rule, been successful at high speeds such as are employed in machines of European design.

*Abstract of paper presented before the American Society of Mechanical Engineers, at Pittsburg.

During the past twenty years, American blowing-engine practice has assumed rather set forms; certain types of valves and engines have dominated the market, and their operation furnishes today the blast for more than 90 per cent. of the pig-iron industry in this country. A few years ago, however, the contentedness of American builders and users of blowing engines was rudely shattered by a double European invasion: the gas engine and the turbo-blower.

The gas engine, although more economical of fuel than the steam engine, is more expensive in first cost. To reduce the cost per horsepower, high piston speed must be employed; thus the piston speed has been increased from the 300 feet per minute, heretofore considered standard in steam-driven blowers, to 600 feet per minute in modern American gas-driven blowers. In Europe reciprocating blowers run at piston speeds of 750 feet per minute, the gas engines for the generation of power running at speeds very close to 1000 feet per minute.

An understanding of the reasons why the standard types of American blowing engines are so successful at medium speeds and what their shortcomings are at high speeds will be facilitated by a study of the valve motion and of the throttling losses through the valves.

As a high velocity through valves is harmful, the tendency is to keep the velocity at a fairly constant low value; and since the piston of an engine has very nearly harmonic motion, it follows that the valve should also have harmonic

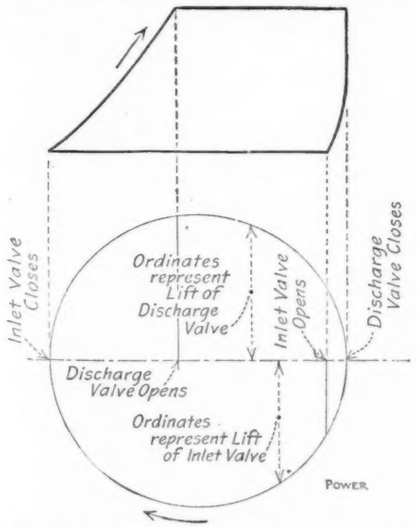


FIG. 1. IDEAL VALVE MOTION ON A DISPLACEMENT BASIS

motion. Fig. 1 shows the valve lift on a displacement basis. The inlet valve is open practically throughout the stroke; the outlet valve should pop open near the middle of the stroke and close at the end.

Fig. 2 shows this same ideal diagram on a time basis. It will be noted that the curves intersect the base line at an angle, indicating that if these ideal-motion curves are realized the valve will strike a blow in seating. The velocity of striking depends upon the lift of the

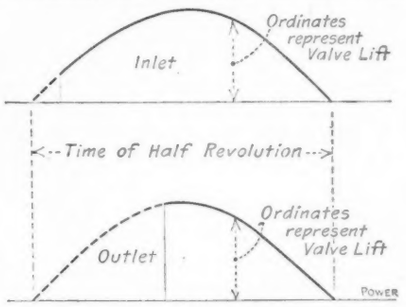


FIG. 2. IDEAL VALVE MOTION ON A TIME BASIS

valve and upon the time of one revolution, which means that high-lift valves, while successful for low rotative speeds, become impractical for high rotative speeds.

Engineers have striven to design valves and valve gears for blowing engines so that these valve-motion curves are approximated. There are, however, two circumstances which interfere with attaining the ideal: One is the quantity of air under a lift valve, which lessens the discharge through the valve during its lift and increases the discharge during the closing period; the other is the mass of the valve, which has frequently baffled designing engineers.

Practically all automatic-lift valves close late, depending upon the rotative speed of the engine, lift of the valve and spring loading. The lower the rotative speed and the valve lift and the greater the spring load closing the valve, the nearer the valve is to the seat in the dead-center position of the crank. Tests and calculations show that in ordinary American blowing-engine practice the valves close so near the dead center that for all practical purposes they may be considered as closing "on time" and without the injurious effects of late closing, namely, the slipping back of the air and the hammering of the valve.

The behavior of the outlet valves is similar to that of the inlet valve with two exceptions: First, the valve has to

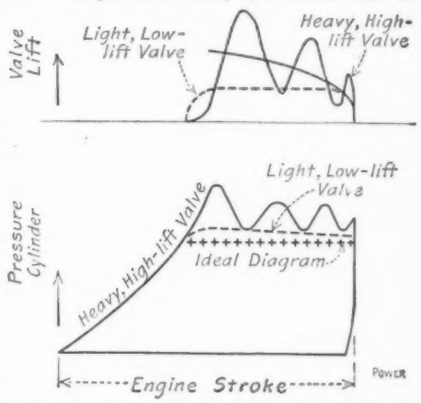


FIG. 3. ACTUAL MOTION OF OUTLET VALVES ON DISPLACEMENT BASIS

open when the piston is moving fastest; second, the pressure difference on both sides of the valve increases rapidly at the dead center. In Fig. 3 the ideal and the actual valve-lift curves are shown in connection with an indicator diagram on a displacement basis. The slower the rotative speed of the engine, the lighter the valve and the smaller its lift, the more perfect is the approximation to the ideal lift curve. High rotative speeds, heavy valves and small areas uncovered by the valve for a given lift cause the pressure in the cylinder to rise considerably over that existing in the blast space and store up a considerable amount of kinetic energy in the valve which must be taken care of by a cushioning device; otherwise fluttering or hammering results. The pressure drops rapidly under the valve immediately after the crank has passed the dead center, and particular care must be taken to have the valve close promptly in order to avoid hammering.

Throttling loss through valves involves two factors: loss of velocity head and surface friction. The vast majority of valves are so designed that surface friction, such as occurs in long pipes or ducts, is practically absent. For this reason, losses due to velocity head only will be considered. Fig. 4 gives the throttling loss for various piston speeds

and for various ratios of valve area to piston area. In this chart the valve area does not mean the so-called free valve area, which is a rather imaginary or conventional quantity, but rather the area actually offered to the flow of air at the narrowest part of the valve. It is assumed that the valve has harmonic motion and that the coefficient of discharge is 70 per cent. For a number of valves this latter figure was found to agree closely with the tests.

As long as the clearance volume of the engine is small, mechanical operation of the inlet valve is scientifically correct, because the opening and closing points of the valve remain practically fixed in spite of variations of blast pressure. Conditions are quite different with the outlet valve. Its correct opening point varies with the blast pressure and losses occur if the valve opens at a fixed point and if the blast pressure differs from the one for which the engine was designed.

Naturally, the experiment of running the standard types of valve gears at higher speeds was tried. Comparatively little trouble was experienced with the mechanically operated inlet valves, except that in some of the designs the throttling loss was much greater than might be expected. At 600 revolutions per minute the standard valve gears gave throttling losses ranging from 0.4 to 1 pound per square inch, and engineers were trying to increase inlet-valve areas up to 20 per cent. or more. At the discharge end serious troubles occurred with an increase in speed.

If the American standard valve gears are used for piston speeds of 600 feet per minute or above, inlet-throttling losses of 3 to 6 per cent. of the ideal blowing work occur, and outlet-throttling losses of 7 to 12 per cent. of the ideal blowing work. Besides, power for mechanical operation of the valves increases and other troubles of wear, breakage or regulation appear, depending upon the valve gear.

For piston speeds up to 600 feet per minute and for rotative speeds up to 65 revolutions per minute, the Slick tub, employing a movable cylinder, has been very successful. The design has been severely criticized as "wagging the dog and holding the tail still" and the author confesses that he felt the same way when he saw the first Slick compressor more than ten years ago at the Edgar Thompson Steel Works, but the ingenuity of the design is forcibly impressed upon anybody who attempts to produce the same combination of large areas and small clearance space in some other way. If 65 revolutions per minute are exceeded with this type, trouble begins. The inertia forces of the heavy cylinder are hard to take care of and heat the eccentric which moves the cylinder.

Engines employing the Mesta combination inlet and outlet valve have been very successful up to piston speeds of 820 feet per minute. In this type rocking valves, two for each head, control both inlet and outlet; the inlet passes at the side of each valve, the outlet through the center of the valve. Automatic cup outlet valves are located beyond the rocking valves and are protected against the return closing slam by the mechanical closing of the rocking valves. This latter design has been used on vacuum pumps and compressors for over 20 years. Its adaptation to high-speed blowing-engine practice required doubling the valve equipment for the purpose of obtaining large areas without excessive diameter of rocking valve. The pot outlet valve is cushioned very little and is loaded lightly

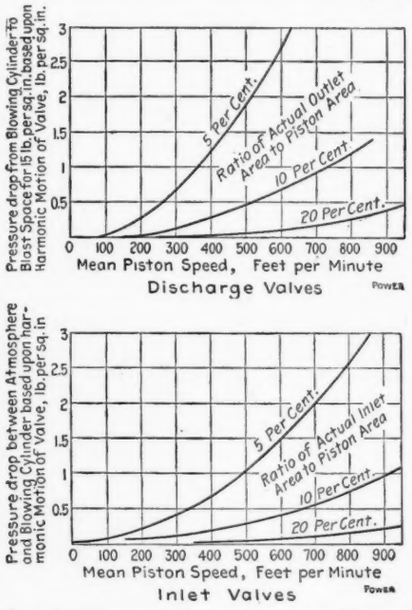

Pressure drop from Blowing Cylinder to Blast Space for 15 lb. per sq. in. based upon Harmonic Motion of Valve, lb. per sq. in.
3
2.5
2
1.5
1
0.5
5 Per Cent.
Ratio of Actual Outlet Area to Piston Area
10 Per Cent.
20 Per Cent.
0 100 200 300 400 500 600 700 800 900
Mean Piston Speed, Feet per Minute
Discharge Valves
POWER
Pressure drop between Atmosphere and Blowing Cylinder based upon harmonic Motion of Valve, lb. per sq. in
3
2.5
2
1.5
1
0.5
5 Per Cent.
Ratio of Actual Inlet Area to Piston Area
10 Per Cent.
20 Per Cent.
0 100 200 300 400 500 600 700 800 900
Mean Piston Speed, Feet per Minute
Inlet Valves
POWER

FIG. 4. PRESSURE LOSS THROUGH VALVES DUE TO VELOCITY HEAD

so as to fly out of the road of the blast without fluttering.

In Europe the high-speed blowing engine is an accomplished fact. There the problem has been attacked along altogether different lines. European engineers long since realized that the harmful kinetic energy stored up in a valve is proportional to its mass and to its travel, and that both should be cut down.

Furthermore, European engineers do not hesitate to use large clearance spaces if by so doing other advantages can be gained, and they meet with success. Matters are different in this country. Clearance in a blowing engine seems to be an eyesore to the American furnace man. The influence of clearance can be summed up in a few words.

a Clearance volume increases the necessary size of blowing tub for a given weight of air to be pumped per stroke.

b The larger size of blowing tub results in a small increase of friction work and, therefore, in a larger size of power cylinder.

c The influence of the increased heat-exchanging surface on the true volumetric efficiency is small.

On the other hand, clearance allows the use of very large valve areas, which decrease throttling work and cause better filling of the air cylinder and also allow higher piston speeds, or in other words, a smaller and cheaper engine. The higher piston speed makes possible the use of a more efficient prime mover, namely, the gas engine. When the truth of this is realized, recognition of the merits of the modern European high-speed blower should present no difficulties. The plate valves are so light in weight and the spring load can be made so small that for the greater part of their working time the valves rest against the guard or stop; this, of course, greatly reduces fluttering. Furthermore, there are no wearing parts and no sliding surfaces or sticking or binding from gummed and dusty oil. The low lift does not allow the valve to acquire destructive velocity in closing. If a sufficient number of valves are used the pressure loss through the valves is small and the filling of the cylinder is almost perfect. The life of the valves is long, provided that they are made of the proper high-grade steel and that the spring loading is properly proportioned. If a valve should break, it can easily be replaced because the valves are light; besides, the inlet and outlet valves are alike so that only a few need be carried in stock.

Particular emphasis is placed upon the almost silent operation of these valves, both by users and builders. No separate cushioning means are employed except that in the Hoerbiger-Rogler valve an elastic plate softens the impact of the opening stroke before the valve strikes the guard. This cushioning alone does not suffice, but another circumstance comes in helpfully. Thin films of oil coat the valve plate, cushion plate and guard. The squeezing of the air and oil between these plates provides a sufficient cushion to prevent injury to the valve.

From a study of the various types of valves and valve gears, it appears that at the present time the low-lift, alloy-steel plate valve promises to become the standard valve for high-speed blowing engines, because there is neither wear, binding nor sticking; no lubrication is required; there are very small throttling losses; it can be used for the highest speeds; it is inexpensive; and it does away with mechanical gearing, oiling and adjustment.

No matter with what valves a reciprocating blower is equipped, its delivery remains discontinuous; that is, it delivers air impulses comparable to a constant delivery, over which is superimposed a wave motion or vibration. If the blower discharges directly into the blast main, then vibrations are transmitted with un-

diminished strength and shake the whole line. In steam-engine practice this evil was cured long ago by placing a large steam or water separator near the engine to damp the vibrations of the pipe line. If a similar request is made of a furnace man for the air line, a great deal of resistance is encountered. The author knows of only one furnace plant in this country where a large tank or equalizer was installed for each blowing engine. The pipe lines thus connected are practically free from vibration.

In conclusion it may be said that the reciprocating blower has made wonderful strides in the past decade toward becoming a successful high-speed machine. While the increase of piston speed was started by the gas engine as a matter of necessity, it has also benefited the steam-driven blowing engine, and isolated furnace plants can now work with two air cylinders instead of three, because one will successfully blow a furnace in case of emergency, or else three smaller units may be used.

The combination of the high-speed reciprocating blower with the blast-furnace gas engine makes the use of the latter profitable even in the Pittsburg district where coal is cheap. The latest group of furnaces in this region has been equipped with slow-speed reciprocating steam-driven blowers. If a high-speed gas-driven blower had been on the market, the result would probably have been different.

A gas-driven blowing engine with a piston speed of 800 to 900 feet per minute and a high rotative speed will be the most formidable competitor of the turbo-blower, if European experience may be taken as a guide. There are engineers in this country who have already carried into practice higher piston speeds for gas engines for electric power, and interesting developments in this line of work may be expected in the next five years.

Discussion

The following discussion applies to both Mr. Trinks' paper and that of Mr. Rice, printed in the June 13 issue:

Mr. Johnson: It is generally accepted that the turbo-blower is much more efficient at low pressures than at high pressures, whereas the reciprocating blowing engine is more efficient at high pressures. A condition in the design of the latter is that the air cylinder must be large enough for the greatest volume to be handled, and strong enough for the highest pressures attained. This results in the large and massive construction which makes such machinery so expensive.

The turbo-blower, on the other hand, suffers because it must have stages enough to furnish the highest pressure likely to be required, although, in ordinary operation, this pressure may be needed only a very small part of the time. Therefore, the best and cheapest blowing engine is a combination of these two types: a turbine-driven blower delivering air, partly compressed, to a reciprocating blowing engine, which will compress it to the desired pressure. The steam from the reciprocating engine could be used to drive the turbine.

In general, the valves of a blowing engine are a source of difficulty, it being almost impossible to get an inlet valve of sufficient area to allow the cylinder to fill without heavy loss by suction, and at the same time be quick enough to give the desired results at the speeds required in modern engines.

The advantage of maintenance is undoubtedly with the turbo-blower, as compared with the reciprocating engine. However, the magnitude of the alternations of stress in the reciprocating blower is greatly reduced by delivering partly compressed air, and the difficulties of the inlet-valve gear are practically eliminated by delivering denser air under pressure.

The governing of such a combined unit is extremely simple. The ordinary governor on the engine does all that is necessary and no governor other than one to prevent racing is needed on the turbine. The steam from the engine passes directly to the turbine, and as long as conditions remain constant, the speed of the turbine will remain unchanged. If, however, the pressure required by the furnace increases, more steam is admitted to the engine by the governor and this increased quantity of steam causes the turbine speed to increase slightly and, in turn, deliver air at a higher pressure. This automatically compensates for any slight lag due to the greater load on the engine and for the lower volumetric efficiency of the reciprocating blowing engine at higher pressures.

C. G. de Laval: It is well to consider the distinction between a blower and a compressor, in which connection it would appear that the machine described by Mr. Rice is not a compressor but a turbo-blower. It is of the multi-stage type and has no rubbing surfaces, the rotating parts revolving freely with ample clearances.

The turbo-compressors manufactured by a number of German firms are made up of multiple cylinders according to volume and pressure. The general principle includes high-speed impellers incased in cylindrical chambers, properly cooled both radially and axially. These impellers draw in the air and discharge it, converting the velocity into potential energy in the form of air pressure, the action being similar to that of a centrifugal-pump impeller.

It does not appear necessary to use six stages, arranged in series, for pressures as low as 10 or 20 pounds per square inch. A turbo-blower built on the Rateau principle for 6000 to 12,300 cubic feet of free air per minute at pressures of 8 to 13 pounds and speeds of 3400 to 3900 revolutions per minute, requires only three stages as against the six stages in the one described by Mr. Rice. For pressures of 80 to 150 pounds it is not necessary to employ more than ten to fifteen stages.

European practice has shown that turbo-compressors with capacities of 6000 cubic feet of free air per minute and above, will give from 70 to 80 per cent. efficiency; for capacities of 3000 to 6000 cubic feet, the efficiencies are from 65 to 70 per cent., and these efficiencies decrease to less than 50 per cent. at one-half and quarter loads.

The use of a turbo-blower in connection with reciprocating compressors has been tried recently in England. The existing compressor was coupled to a turbo-blower, the exhaust from the low-pressure steam cylinder passing to the steam turbine; the turbo-blower takes air at atmospheric pressure, compresses it and discharges to the reciprocating compressor where the pressure is stepped up to 60 pounds. This combination has doubled the capacity and has shown a net gain of 17 per cent. over that which would have been secured had an additional reciprocating compressor been installed. Furthermore, it saved the expense of an addition to the building, which would have been necessary on account of the large space occupied by an additional compressor.

Mr. Baker: Taking all factors into consideration, under certain conditions of fuel cost, the turbo-blower is a close second to the gas-blowing engine. The fuel consumption of the latter is affected by a number of different efficiencies; namely, the efficiency of the blowing tub, which may be called the compression efficiency, the volumetric efficiency and the mechanical friction of the blowing tub. The sum of these efficiencies is the shaft efficiency, which may be compared with the so called shaft efficiency of the turbo-blower.

The compression efficiency is the ratio of the work required to compress adiabatically to that actually required in the blowing tub; this amounts to about 94 per cent. The losses are due principally to the inertia and friction of the discharge valves, the friction of air passing through the suction and discharge passages, and to late opening of the suction valve.

The volumetric efficiency has been actually determined by a long series of tests on various engines, and has been found to be about 89 per cent. The losses are due to defective clearance, friction of air through the suction valves, leakage of air past the valves and piston, and to the effect of preheating the incoming air.

The mechanical efficiency of the blowing tub is not easily determined, but was estimated at 90.4 per cent. These make a total shaft efficiency of 75.8 per cent. which may be compared with 68 to 70 per cent. efficiency for the turbo-blower.

Mr. Cardullo: Builders of blowing engines could take lessons from the pumping-engine manufacturers, and build engines with smaller discharge valves. The valves illustrated by Mr. Trinks are 18 or 20 inches in diameter and of a type which is unsatisfactory in water-pumping work. Although they will be more satisfactory in air work than in water pumping, the objections are of the same character and at high speeds are of the same validity as the objection to similar valves in water pumps. The difficulties could be overcome by substituting a large number of small valves of suitable material, about three inches in diameter.

Mr. Freyn: As far as thermodynamics is concerned, the turbo-blower indirectly uses two and one-half times as much gas as the gas-blowing engine. Regarding the relative cost of the two types of installation, based upon actual figures, consider four or five 100-ton blast-furnace plants, with eight gas-blowing engines installed, six operating the furnaces and two spares, and six turbo-blowers, four operating the furnaces and two spares. Under such conditions it will be found that, taking the thermal efficiency, the constant operation and the fixed charges into consideration, the gas-blowing engine is in the lead, even with coal at $1.80 per long ton.

In isolated blast-furnace plants, however, where the gas has no value, the turbo-blower is the proper installation, especially in plants having one or two furnaces where a constant supply cannot always be depended upon. But for any large plant, particularly blast-furnace plants connected with steel works, it is out of the question to put in turbo-blowers.

There is no doubt that in large steel works it is possible to have electric installations which furnish power at a very cheap cost to the municipalities and industries in the neighborhood. In this connection the gas-blowing engines lead the turbo-blowers.

I cannot see any opportunity for turbo-blowers, with the exception of the one case which Mr. Johnson pointed out, but I have, however, a better suggestion to offer. This is to utilize the waste heat from the gas engine for generating low-pressure steam by which turbine blowers may be run to compress the blast for the furnace.

Mr. Ehrhart: In Mr. Rice's paper is to be found the statement: "The pulsations in pressure above noted are an inherent characteristic of all centrifugal blowing apparatus." I believe that in a machine which is not a positive pushing machine, like a reciprocating engine, this pulsation should be avoided if possible. This is especially important where two machines are delivering air into the same line, in which case they should have the same characteristics.

Furthermore, in the case cited by Mr. Rice, the efficiency at one-third of the rated volume is about 45 per cent. In some blowers with which the Westinghouse Machine Company has been experimenting for the past five or six years, it has been found that by merely altering the shape of the blower the efficiency has been brought up to nearly 70 per cent. at one-third load. I do not believe this point has been brought out before, but blowers are now on the market in which the light-load efficiency is within 5 per cent. of what it is at full load.

Discussion on "Purchase of Coal"

The discussion of Mr. Randall's paper upon the purchase of coal, which was published in the June 13 issue, is herewith presented.

Mr. Rice: It is important that a plant be designed to use coal of lower quality, and all attention should not be directed toward the method of buying coal, the effect of which is to defeat the conservation of our natural resources. The emphasis of this paper, unwittingly perhaps, is to direct purchasers to be more particular with the coal dealer; hence, the latter tries to meet the specifications, with the result that he uses the best coal and neglects to find a market for the poor coal.

Mr. Baker: Quite a number of plants in the East are successfully burning a very low grade of fuel, which it would be impossible to burn by ordinary method. This is accomplished through the use of the steam jet, which, from the thermodynamic point of view, is perhaps bad engineering, yet it enables the fuel bed to be kept cool enough to prevent trouble from clinkers.

Professor Carpenter: I do not see how the ideas that have just been expressed constitute an argument against the necessity of testing coal and of purchasing it by analysis. I have lived for a great many years in those districts bordering on the anthracite-coal regions, where we have had to take the poor stuff that nobody else would use. The coal operators are anxious not only to dispose of their coal, but also some of their heaps of slate, some of which reaches the breakers and rock crushers; and, no doubt, thousands of dollars have been paid by the consumer to help dispose of these slate piles.

Professor Goss: I want to emphasize the statement to which Professor Carpenter has called attention. The coal operator must take much more responsibility for the suitable preparation of his coal, and everything should be done to encourage him in improving the product delivered to the consumer. The inferior coal, of course, should be brought out of the ground and should be saved; but before it is delivered to the consumer the operator should wash and sort it or otherwise put it in proper form.

Mr. Barker: If the plant can be so designed and low-grade fuels are available, it is profitable to change the equipment to use the low-grade fuel. However, the variation in the low-grade fuels is such that it is not profitable for the average plant to attempt to burn them without special attention. For instance, the small size of anthracite which comes to the New England market contains from 14 to 24 per cent. ash. It may be conserving some of our natural resources if this 24 per cent. of ash can be burned at all efficiently, but if the ash can be kept down to 18 per cent., the coal can probably be used to advantage. It may be either burned alone or mixed with a good grade of bituminous coal, but if this coal comes to the market with a variation of 14 to 25 per cent. of ash, there should surely be some correction for this variation in quality.

Mr. Baker has suggested the use of the steam jet in burning low-grade fuel. The steam jet is a very efficient piece of apparatus where a small size of anthracite is burned, providing the fireman is familiar with the apparatus. However, I have found a number of cases where the steam jet was a very inefficient piece of apparatus in a power plant, on account of improper regulation.

Pennsylvania State Convention

The Pennsylvania State Association of the National Association of Stationary Engineers held its twelfth annual convention at Johnstown on Friday and Saturday, June 2 and 3, Cambria Association No. 21 being the host. The delegates and visitors were welcomed to the city by Mayor Wilson, to whom a fitting response was made by Past President Charles A. Garlick. Addresses were made by C. W. Leitenburger, chairman of the local committee; Past President Joseph H. Carney, National Treasurer Samuel D. Forse, and State President F. M. Zimmerman.

On Friday afternoon a visit was made to the Cambria mills. On Friday evening a banquet was given at the Merchant's hotel at which Mr. Forse acted as toastmaster and George D. Yohe, the first president of the Pennsylvania State Association; Martin S. Corbett, president of the local branch, and the speakers of the morning, besides several of the representatives of the Cambria works, made addresses.

The election resulted in the choice of George Bu. Miller, of Pittsburg, as president; D. N. Arms, of Johnstown, vice-president; Thomas C. Green, of Pittsburg, secretary; D. E. Seely, of Du Bois, treasurer; John G. Louis, of Sharon, conductor; E. H. Nettle, of York, doorkeeper. The next convention will be held at York.

Convention of the American Order of Steam Engineers

The twenty-fifth annual convention of the supreme council of the American Order of Steam Engineers was held at Philadelphia, Penn., during the week commencing June 5.

There was a large gathering of delegates from the several councils connected with the organization, the meetings being held in the Parkway building on Broad street.

The large auditorium on the main floor of the building was tastefully decorated and was uniformly and artistically arranged for the exhibit of the American Supplymen's Association. The exhibit this year was the largest yet held, and the demand for booths was so great that many of the exhibitors were given space on the stage, which was fitted up as a reception room, and proved to be one of the most popular places in the hall.

The convention was a lively one for the delegates. There were seven sessions of the supreme body, and considerable important business conducive to the welfare of the association was transacted.

At the Wednesday morning session a recess was taken and permission granted to William G. Le Compte, of Jenkins Brothers, to occupy the floor. Mr. Le Compte stated that he was the bearer of congratulations from his firm to the members of the American Order of Steam Engineers, and in a neat speech presented to the supreme council a handsome solid ivory, gold-mounted gavel, and to each subordinate council a similar gavel, silver mounted, in commemoration of the silver anniversary of the organization.

There was a varied program of entertainment. On Monday afternoon a visit was made to the new John Wanamaker building. An excursion on the Delaware river took place on Tuesday afternoon. Dancing and other enjoyments were indulged in, and abundant refreshments were served.

THE EXHIBIT HALL IN ODD FELLOWS' TEMPLE, PHILADELPHIA

On Thursday afternoon the delegates and guests took special trolley cars for a family outing to Washington park. There were outdoor events of all kinds, the fun ending in a baseball match between the engineers and the supplymen.

The big feature of the entertainment program was the "silver jubilee" banquet on Wednesday evening, at the Scottish Rites hall. There were over eight hundred seated at the tables, including the ladies and their escorts. After an appetizing dinner had been served, George W. Richardson, the toastmaster, introduced the following speakers: Frederick Markoe, supreme chief engineer; Franklin S. Edmonds, of the Board of Education, and Lieutenant Hope, of the United States Army Engineers' Corps.

During the evening a pleasing entertainment was given as follows: Joe McKenna, Jenkins Brothers, songs; Jim Devins, Peerless Rubber Manufacturing Company, monologue; Billy Murray, Jenkins Brothers, popular songs; Jack Armour, POWER, stories and recitals;

THE AMERICAN ORDER OF STEAM ENGINEERS AT PHILADELPHIA

George C. Gray, Watson & McDaniel Company, Scotch songs; Mr. Ryder, Bird-Archer Company, magic; George C. Davis, Thomas Warley & Co., songs.

At the Thursday morning meeting of the delegates the following supreme officers were elected:

Lewis G. Schlehner, chief engineer; George W. Goodwin, first assistant engineer; Florian J. Armbruster, recording engineer; C. F. Noble, corresponding engineer; Thomas J. Donovan, treasurer; T. M. Montgomery, senior master mechanic; F. S. Miller, junior master mechanic; Walter Long, chaplain; Richard Sullen, inside sentinel; William Eccles, outside sentinel; William Parient, trustee.

It was voted to hold the next annual convention at Allentown, Penn.

At a meeting of the American Supplymens' Association on Thursday morning the following officers were chosen for the ensuing year:

Harry Winner, Garlock Packing Company, president; Frank Martin, Jenkins Brothers, vice-president; Fred L. Jahn, Watson & McDaniel Company, secretary; John W. Armour, POWER, treasurer.

The following gentlemen comprise the executive committee: F. V. Stein, H. W. Johns-Manville Company; George C. Davis, Thomas Warley & Co.; J. F. Boreland, France Packing Company; S. McCullam, McCullam & Co.; Albert Schade, Schade Valve Manufacturing Company; Charles A. Hopper, Keystone Grease Company; Charles P. Sanville, McArdle & Cooney Company; Harry E. Souders, John R. Livesey Company; Charles Camp, Strong, Carlisle & Hammond Company; Arthur L. Rice, *Practical Engineer*.

The exhibition hall was formally opened on Monday evening at nine o'clock by A. R. Foley, president of the American Supplymen's Association, who introduced Charles E. Carpenter and Supreme Chief Frederick Markoe, who made appropriate addresses.

There were 81 exhibitors occupying 84 booths. Their names follow: American Engineering and Manufacturing Company, American Order of Steam Engineers, American Steam Gauge and Valve Manufacturing Company, American Pulley Company, Anchor Packing Company, Ashton Valve Company, H. Belfield Company, Bird-Archer Company, Cyrus Borgner Company, A. B. Botfield Company, Brogan & Co., Cancos Manufacturing Company, Corbett Supply Company, Crandall Packing Company, Dearborn Drug and Chemical Works, R. and J. Dick Company, Engineering Equipment Company, Fairbanks Company, France Packing Company, Frick Grate Bar Company, Garlock Packing Company, Greene, Tweed & Co., Harrison Safety Boiler Works, Home Rubber Company, Homestead Valve Manufacturing Company, E. F. Houghton & Co., Huhn Metallic Packing Company, Paul B. Huyette Company, Jenkins Brothers, H. W. Johns-Manville Company, Keasbey & Mattison Company, Keystone Lubricating Company, Lagonda Manufacturing Company, John R. Livesey Company, George W. Lord Company, Lunkenheimer Company, Mason Coal Company, McArdle & Cooney, McLeod & Henry Company, W. B. McVicker Company, Michigan Lubricator Company, National Tube Company, Nelson Valve Company, Ohio Blower Company, Parkersburg Iron Company, Peerless Rubber Manufacturing Company, Philadelphia Bourse, Philadelphia Electrical Construction Company, Philadelphia Grease Manufacturing Company, POWER, *Power House*, William Powell Company, *Practical Engineer*, Pringle Electrical Manufacturing Company, Quaker City Rubber Company, C. J. Rainear & Co., William C. Robinson & Sons Company, E. J. Rooksby Company, Roto Company, Sarco Fuel Saving and Engineering Company, Schade Valve Manufacturing Company, S-C Regulator Company, Smooth-On Manufacturing Company, *Southern Engineer*, Frank H. Stewart Electric Company, Strong, Carlisle & Hammond Company, Trill Indicator Company, Under-Feed Stoker Company of America, H. B. Underwood & Co., Vacuum Oil Company, V. V. Fittings Company, R. G. Von Kokeritz & Co., Thomas C. Warley & Co., Watson & McDaniel Company, Warren Webster & Co., Elisha Webb & Sons Company, Whetstone & Co., Wise & Bailey, Wilkirk Electric Company, O. F. Zurn Oil Company.

The loss of power in a gas engine owing to its installation at considerable elevations above sea level may be roughly estimated at about 3⅓ per cent. for each thousand feet. The decrease in barometric hight is about one inch for 950 feet of altitude.

New York State N. A. S. E. Convention

The delegates from the several branches comprising the New York State Association of the National Association of Stationary Engineers assembled at Albany, N. Y., to hold its sixteenth annual convention on June 9 and 10.

The Globe hotel was the headquarters and in German hall, situated a short distance away, the sessions of the convention were held, as was also the mechanical display.

On Friday morning, June 6, at 10:30, the convention was called to order by Charles Schabacker. After the reports were read and the various committees appointed, an adjournment was taken.

There were two additional sessions of the delegates on the morning and afternoon of Saturday.

On Friday afternoon a resolution was passed that a committee be appointed to request Senator Seth G. Heacock to use his influence to get the State license bill out of the hands of the committee and introduced into the senate on as early a date as possible.

AT THE N. A. S. E. STATE CONVENTION, ALBANY, N. Y.

An earnest appeal to the members was made by J. Douglas Taylor, secretary-treasurer of the life and accident department of the National Association of Stationary Engineers, requesting them to use their best efforts to induce the members of their local associations to join this excellent insurance organization.

The unanimous support of the delegates indorsed James R. Coe as State deputy for appointment by the incoming national president of the main body at Cincinnati in September next.

The election of the State officers then resulted in the following selections:

B. C. Dunsmore, Buffalo, president; George O. Kaley, Brooklyn, vice-president; E. E. Pruyn, Rochester, secretary;

William Downes, New York, treasurer; Harry Bache, Syracuse, conductor; James T. Fitzgerald, Little Falls, doorkeeper; Matthew Bender, Albany, chaplain.

Yonkers was selected as the city in which to hold the next annual meeting, subject to the approval of the Yonkers association.

There were many features of entertainment, including trolley rides to the places of interest about the city and visits to many of the large plants.

On Friday afternoon the assemblage was given the opportunity of calling at the executive chamber to shake hands with Gov. John A. Dix.

On Saturday afternoon the delegates had a delightful sail on the Hudson river.

At Keeler's hotel on Saturday evening a banquet was held to which the ladies were invited. Covers were laid for fully two hundred. There was a varied program of toasts, songs, stories, recitations and instrumental music which was highly appreciated. The addresses were made by the following gentlemen: Arthur L. Andrews, Charles Schabacker, Hon. Judge T. McDonough, Edward H. Kearney, William B. Jones, Hon. John Williams, Counselor James H. Quinn.

The entertainers were Joe McKenna, Jenkins Brothers; Frank Corbett, Consolidated Safety Valve Company; Jim Devins, Peerless Rubber Manufacturing Company; Billy Murray, Jenkins Brothers; Jack Armour, POWER.

A pleasing diversion to the ceremonies occurred when toastmaster Hugh F. McCoubrie called for Past State President Schabacker and presented him a handsome mantel clock on behalf of the delegates of the State association. Mr. Schabacker made an appropriate response.

The exhibits were well located in the main auditorium on the second floor of the convention hall. The booths were unusually large and comfortable, and were occupied by the following firms: Albany Belt and Supply Company, Albany Chamber of Commerce, Albany Lubricating Company, Ashton Valve Company, Bird-Archer Company, Ball Engine Company, Crandall Packing Company, M. T. Davidson Company, Dearborn Drug and Chemical Works, Fairbanks Company, Garlock Packing Company, Greene, Tweed & Co., Harrison Safety Boiler Works, Holmes Metallic Packing Company, Home Rubber Company, Homestead Valve Manufacturing Company, Jenkins Brothers, H. W. Johns-Manville Company, Keystone Lubricating Company, Lunkenheimer Company, McLeod & Henry Company, W. B. McVicker Company, Morehead Manufacturing Company, *National Engineer,* Neemes Brothers, George M. Newhall Engineering Company, New York Belting and Packing Company, Ohio Blower Company, Otis Elevator Company, Peerless Rubber Manufacturing Company, Philadelphia Grease Manufacturing Company, POWER, *Practical Engineer,* J. L. Quimby & Co., Roto Company, Royersford Foundry and Machine Company, *Southern Engineer,* C. E. Squires Company, Strong, Carlisle & Hammond Company, W. N. Swarthout & Co., George H. Thacher & Co., Union Steam Pump Company, Yarnall-Waring Company.

SOCIETY NOTES

The American Society of Heating and Ventilating Engineers will hold its semi-annual meeting in Chicago, Ill., on July 6, 7 and 8.

The third annual convention of the Engineers-Janitors' Association of the Public Schools of New York State will be held in Syracuse on Friday and Saturday, August 4 and 5, 1911, at Fobes hall, Educational building, corner of West Genesee and North Clinton streets. The association was organized two years ago in Albany, and within that period two cities in the State have had pension bills passed to aid the janitors in their declining years. Other cities have had their boards of education awakened to the fact that the engineer-janitors of their schools were not receiving a just compensation for the work required of them and have tried to give them what was due them as far as they were able.

PERSONAL

Martin G. Langguth, Portland, Ore., has been appointed engineer-in-charge of the power plant in the State house at Salem.

At a dinner given to Col. E. D. Meier in honor of his seventieth birthday at the Beaux Arts Club, New York City, on May 29, the employees of the Heine Safety Boiler Company gave him a complete surprise by presenting to him a fine Zeiss telescope and microscope. Among those present were men who started when the company was formed over thirty years ago.

After the dinner, Colonel Meier left for Pittsburg to preside at the spring meeting of the American Society of Mechanical Engineers, where he was honored by a testimonial from the society.

NEW PUBLICATION

THE SPONTANEOUS COMBUSTION OF COAL WITH SPECIAL REFERENCE TO BITUMINOUS COALS OF THE ILLINOIS TYPE. By S. W. Parr and F. W. Kressmann. Has just been issued as Bulletin No. 46 of the engineering-experiment station of the University of Illinois.

The Bulletin describes a series of experiments directed toward the determination of the fundamental causes underlying the spontaneous combustion of coal. These causes may be summarized as follows: (1) External sources of heat, such as contact with steam pipes, hot walls and the impact of large masses in the process of unloading, hight of the piles, etc.; (2) fineness of division; (3) moisture; (4) activity of oxidizable compounds, such as iron pyrites. An historical review of the literature upon the spontaneous combustion of coal is given in the appendix. Copies of this bulletin may be obtained gratis upon application to W. F. M. Goss, director of the engineering-experiment station, University of Illinois, Urbana, Ill.

Engineering Societies Library

The facilities offered by the library of the Engineering Societies, at 29 West Thirty-ninth street, New York City, have recently been called to our attention. The library is formed from the combined libraries of the American Institute of Electrical Engineers, the American Society of Mechanical Engineers and the American Institute of Mining Engineers, and contains over forty thousand volumes on engineering subjects. It is open for reference to the general public, without charge, every day and evening, except Sundays. The library is supplied with all the published indexes, has most complete sets of periodicals both domestic and foreign, and has a well trained reference staff.

Students residing in New York City and vicinity are especially invited to use the library in their researches on technological subjects. The library is on the top floor of the United Engineering Societies building, is quiet, well lighted and ventilated. Those who are prevented from visiting the library by distance or business engagements may nevertheless receive assistance. It is prepared to furnish references on engineering subjects to persons at a distance, and also to furnish transcripts, translations and photographic reproductions of diagrams and maps. For such work, if extensive, a moderate charge is made. Correspondence is welcomed; telegraphic and telephonic inquiries will receive especial attention.

Fort Wayne Electric Works Merged with General Electric

On June 1, the Fort Wayne Electric Works was merged with the General Electric Company, of Schenectady, N. Y. Its business will be conducted under the name of Fort Wayne Electric Works of General Electric Company. The same lines of apparatus and supplies will continue to be manufactured and sold under the immediate direction of the same individuals as heretofore, with F. S. Hunting in responsible charge as general manager.

Moments with the Ad. Editor

A department for subscribers edited by the advertising service department of Power

The priest who had been summoned in haste, as a substitute, to officiate at a funeral, was making a few remarks about the deceased. Wishing to make some allusion to the departed one, he suddenly realized that he didn't know the name or even the sex of the one in the coffin. To get the necessary information, without letting anyone know his predicament, he turned quickly to Pat, who was a mourner, and asked, under his breath, "Pat, is it a brother or a sister?" "Neither," replied Pat, "it's a cousin!"

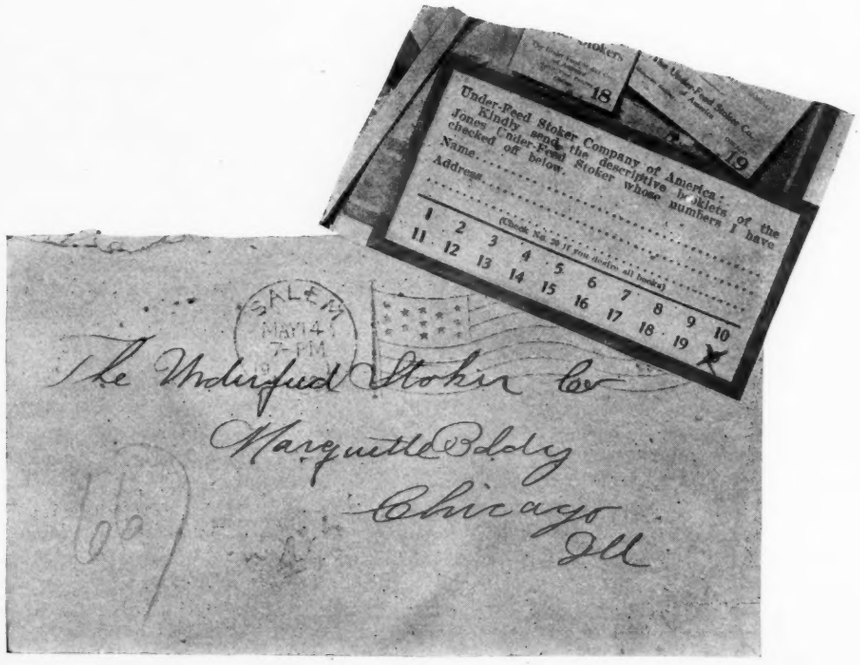
All of which shows that there are times when one's name and identity are important.

The other day the Under-Feed Stoker Company of America sent us the clipping from their POWER ad. and the envelope which are reproduced here.

Some engineer, in Salem, Mass., read their ad. in POWER and was so interested in their proposition that he sent in the coupon asking for all 20 of their booklets and even offered to pay for them if necessary—*but*, he failed to give his name and address.

No doubt he is still wondering why the advertiser hasn't made good his offer to send the printed matter.

And this occurrence is not so unusual as you might think.


Under-Feed Stoker Company of America
Kindly send the descriptive booklets of the Jones Under-Feed Stoker whose numbers I have checked off below.
Name
Address
1 2 3 4 5 6 7 8 9 10
11 12 13 14 15 16 17 18 19
SALEM
MAY 4
7 PM
The Underfeed Stoker Co
Marquette Bldg
Chicago
Ill

Perhaps it isn't often that the reader neglects to give his name and address, but in a great many cases he fails to answer necessary questions which the advertiser asks—answers to which he must have before he can send out intelligent information.

Readers should realize that the ads cannot tell *all* there is to be told about a product.

The complete story is left to the catalogs, booklets and letters which the advertisers have prepared to send to all who become interested through the advertisements.

It is this expansive modern way of doing things that has made advertising a great educational force.

The advertiser does his part at great expense of time and money—

You do your part by reading the ads. and giving the advertiser a fair chance to send you intelligent information on how his product will benefit your plant.

And don't forget to say who and where you are.

We have printed this case because it contains a little "moral" for our readers—and also in the hope that the Salem engineer will read it, realize his mistake and send along his name and address.

BUSINESS ITEMS

The Allegheny County Light Company, of Pittsburg, Penn., placed an order with the Westinghouse Electric and Manufacturing Company for ten 250-kva., and two 200-kva. transformers of the oil-insulated, self-cooling type.

Spencer Neemes, of Neemes Brothers, Troy, N. Y., started on June 11, for an extensive automobile trip through the West. Mr. Neemes expects to be gone about six weeks, and will stop at the principal cities between Troy and Lawrence, Kan.

The Philadelphia Electric Company has just given the American Ship Windlass Company, manufacturer of the Taylor stoker, its third order covering eight stokers, which make a total of practically 15,000 horsepower of Taylor stokers in the Christian street station.

The St. Mary's Machine Company, St. Mary's, Ohio, is placing on the market an attachment for using gas oil and crude oil as engine fuel for combustion engines. It claims that with these low-grade distillates it can develop a horsepower per hour for less than one-half cent. It will send circular and particulars to anyone interested.

Miss Helen Gould is building in Constantinople, Turkey, an American college for girls. Everything used in the equipment of the building is to be bought in the United States. The order for grate bars has been awarded to Neemes Brothers, of Troy, N. Y., who will supply four sets of grates, 6x6 feet, to burn soft coal with mechanical draft.

The Terry Steam Turbine Company is to build a large addition to its shop at Hartford, Conn., in order to meet the increasing demand for the Terry turbine, which is being extensively used for driving centrifugal pumps, generators, fans, etc. The new part will more than double the capacity of the present plant and will be added to the eastern end of the shop, which was completed two and a half years ago. The plans are completed and bids have been called for so that the construction may be begun as soon as possible.

NEW EQUIPMENT

Walter Baker Company, Milton, Mass., will install boilers.

New Britain, Conn., contemplates extending its water supply.

Wilkie, Sask., will install a new waterworks pumping plant.

Southampton, Ont., will make additions to its water-pumping plant.

The city of Holyoke, Mass., will install a boiler at the Alms House.

The Eastern Talc Company, Rochester, Vt., will erect a new power plant.

Cardston, Alberta, will install a complete new waterworks pumping system.

The citizens of Sebewaing, Mich., voted to install a municipal electric-light plant.

C. W. Dean & Co., Cochituate, Mass., are taking figures on power-house equipment.

John Maddox & Sons, Trenton, N. J., will increase the capacity of its power plant.

Fire destroyed the plant of the Mines Power Company, at South Lorraine, Ont.

The Pacific Fruit Express Company, Brawley, Cal., is erecting a new pre-cooling plant.

The Prince Rupert (B. C.) Hydro Electric Company will equip a new $5,000,000 system.

Carmangay, Alberta, will equip a new electric-light plant and also waterworks system.

Jas. L. Humphrey, Jr., New Bedford, Mass., will build an addition to its cold-storage plant.

The Lincoln Trust Company, Jersey City, N. J., will increase the capacity of its power plant.

Newberry, Mich., is considering the issuance of $11,500 bonds for municipal electric-light plant.

Pittsfield, Mass., has made an appropriation of $56,500 for extending water and sewage system.

The San Francisco (Cal. Gas and Electric Company is having plans prepared for a new power plant.

The Worcester Suburban Electric Company will build an addition to its power station, at Uxbridge, Mass.

Equipment will be purchased for two municipal electric-light plants by the city of Cleveland, Ohio.

The United States Government will install electric pumping machinery, at Fort Ethan Allen, Essex, Vt.

The city council, Pottstown, Penn., will vote on the question of erecting a municipal electric-light plant.

The Mason (Mo.) Light and Power Company is planning for the installation of a waterworks system.

The Washington Hospital for the Insane, Medical Lake, Wash., will build an addition to its power plant.

The Oregon Power Company, Eugene, Ore., is planning to install a new waterworks system at Albany, Ore.

The Philadelphia (Penn.) Electric Company will erect an engine house at Thirty-first and Jefferson streets.

Refrigeration and other equipment will be required for a new hospital to be erected by the city of Cleveland, Ohio.

The Klamath Falls (Ore.) Water Users Association is planning the erection of a power plant on the Klamath river.

The Kern County Water Company, Bakersfield, Cal., is having plans prepared for a new power plant to cost $100,000.

The Dayton (Ohio) Power and Light Company has raised its capital to $20,000,000, and will increase its capacity.

The Eastern Minnesota Power Company has been granted a franchise to install an electric-light plant in Princeton.

The Commonwealth Brewing Company will erect a boiler and engine house, at 2730 Cambridge street, Philadelphia, Penn.

The Grangeville (Idaho) Light and Power Company is planning for the erection of a power plant in the Ten Mile section.

The Marion (N. Y.) Power Company will issue $9500 bonds, proceeds to be used for the construction of an electric-light plant.

The village council, Braham, Minn., has granted the Eastern Minnesota Power Company a franchise to install an electric-light plant.

The Board of Education, Yonkers, N. Y., has let contract for the erection of a power house for the Saunders Trade School, to cost over $11,000.

Pasadena, Cal., contemplates additions and improvements in its municipal lighting plant to cost $35,000. C. W. Koiner, superintendent.

Power-plant equipment will be required for the new 12-story building to be erected by the City and County Medical Association, Portland, Ore.

Hollipeter & Jontz, owners of the electric-light plant at Blytheville, Ark., are said to be contemplating the installation of a cold-storage plant.

The Northern Ohio Traction and Light Company will build a steam turbine plant, reservoir and a hydroelectric plant, at Cuyahoga Falls, Ohio.

HELP WANTED

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

ENGINEERS to solicit orders for the Rolin patent adjustable grate bar. Apply Standard Grate Co., Heed Bldg., Philadelphia, Penn.

WANTED—Thoroughly competent steam specialty salesman; one that can sell high-grade goods. Address "M. M. Co.," POWER.

AN ENGINEER in each town to sell the best rocking grate for steam boilers. Write Martin Grate Co., 281 Dearborn Street, Chicago.

AGENTS WANTED for first-class steam specialty in use throughout United States. Address C. S. Wood, 410 S. 15th St., Philadelphia, Penn.

THE VULCAN SOOT CLEANER offers an exceptional opportunity for power specialty salesmen. For further particulars address G. L. Simonds & Co., 802 Steinway Bldg., Chicago, Ill.

SALESMAN calling at power plants to handle as a side line superior packing for steam, different from the rest and better. Nugget Packing Co., 185 Summer St., Boston, Mass.

WANTED—An engineer in each city as agent for a high class water-back Scotch boiler, the most economical steam generator known to the trade. Kingsford Foundry & Machine Works, Oswego, N. Y.

WANTED—Gas engineer; man familiar with Westinghouse horizontal engines, capable of taking charge of plant equipped with a 500-kilowatt horizontal and a 100-kilowatt vertical gas engine, located in central New York on railroad; large house electrically lighted; rent free to married man; state age, experience and salary wanted. Address Salisbury Steel & Iron Co., Utica, N. Y.

SITUATIONS WANTED

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

POSITION WANTED by chemical, electrical and mechanical engineer; technical graduate; four years' experience in industrial analysis of ores, oils, foods, water purification, bacteriology and the design and operation of machinery; best of references. Address "E. F. B.," 41 Scottwood Apt., Toledo, Ohio.

TECHNICAL MAN, 34, married, 13 years' experience, power, light, telephone, construction and operation, want connection as electrical engineer or superintendent, light or power plant; good business ability; prefer West or South; would consider foreign country. Box 433, POWER.

MISCELLANEOUS

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

PATENTS. C. L. Parker, Patent Attorney, ex-examiner Patent Office, 904 G St., Washington, D. C. Write for Inventor's Handbook.

AGENCY REQUIRED by English firm with offices at Leeds, Yorkshire, for colliery (by-product coke oven) and mill furnishing specialties. Apply, giving full particulars, Box 452, POWER.

EVERY ENGINEER should be posted regarding the new system of vacuum heating installed without payment of royalty; I have valuable information: write today. T. L. Reeder, 1417 W. Jackson Blvd., Chicago, Ill.

FOR SALE

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

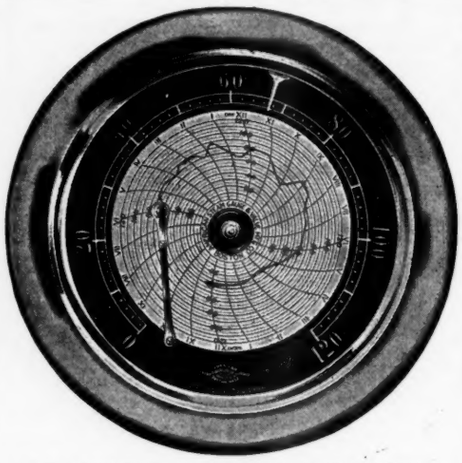
FOR SALE—Wain wright corrugated copper tube feed water heater. The St. John Wood Working Co., Stamford, Conn.

FOR SALE—Wetherill Corliss engine, 24x36 x48 cross compound, 800 to 1000 horsepower. Robt. Wetherill & Co., Inc., Chester, Penn.

FOR SALE—20x48 Wheelock engine and two 72"x18' high pressure tubular boilers in good condition cheap. Address "Engineer," Box 2, Station A, Cincinnati, Ohio.

FOR SALE—Gas engine, 100-horsepower Foos three-cylinder vertical 14x14; and 100-

The American Pressure and Recording Gauge



The American Pressure and Recording Gauge

Assures Careful Firing

Tells you what pressure was carried on the boiler at any time during its operation.

Keeps you in constant touch with what's going on in the boiler room.

Tells you if the fire is being carefully tended; shows when the fireman neglects his duty.

Can be installed in the manager's office or in any part of the plant.

For the manager it means a safeguard against careless firing.

For the engineer and fireman, if their work is ably done, it means a daily proof before the manager that they are the right men for their jobs.

It's a money saving device for small and large plants.

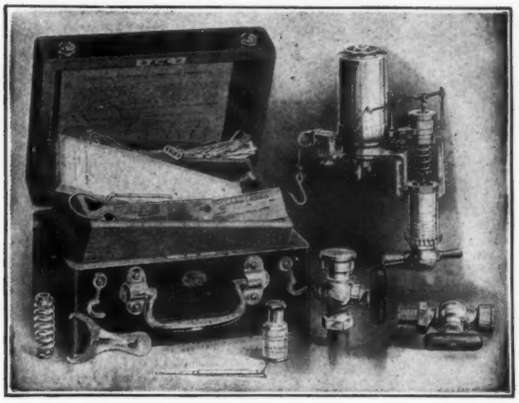
Write for full particulars.

American Steam Gauge & Valve Mfg. Co.

Boston, Mass.

New York, 30 Church St. Atlanta, 525 Candler Bldg. Chicago, 130-132 No. Jefferson St.
Pittsburg, 8076 Jenkins Arcade Bldg. San Francisco, Monadnock Bldg. Montreal, 444 St. James St.

Which Do You Want—The ORIGINAL or the IMITATION?



We marketed the original THOMPSON indicator 35 years ago.

Since then, a number of imitations have been marketed.

Right in this very paper, these imitations are advertised.

If they are just as good, why don't they bring the same price?

If they are just as good, why didn't they adopt and build up a name for themselves, not appropriate ours?

Can you name a single imitation as good as the original article?

Then, once again do we ask

Which do you want, the ORIGINAL or the IMITATION?

American Steam Gauge & Valve Mfg. Co.

The Manufacturers of the Original Thompson Indicator
THE AMERICAN-THOMPSON

Boston, Mass.

New York, 30 Church St. Atlanta, 525 Candler Bldg. Chicago, 130-132 No. Jefferson St.
Pittsburg, 8076 Jenkins Arcade Bldg. San Francisco, Monadnock Bldg. Montreal, 444 St. James St.

horsepower Smith gas producer with all equipments; installed for inspection; nearly new; reason for selling, to install 250 horsepower. Box 451, POWER.

FOR SALE—For immediate delivery, two Cooper Corliss engines, direct connected to Westinghouse direct-current, 125-volt generators, 100 r.p.m., sizes 100 to 200 kilowatts; also one Westinghouse vertical direct connected unit 25 kilowatt capacity, 125 volts, direct current. Box 449, POWER.

FOR SALE—One compound Reynolds Corliss engine, high pressure cylinder 32 inches, low pressure 60 inches, stroke 60, 1200 horsepower at 100 pounds pressure, 70 revolutions per minute, flywheel diameter 20 feet, face 56 inches, built in sections; shaft length 16 feet diameter in wheel 16 inches, single eccentric. Box 434, POWER.

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All Kinds of Steam Engines Need Cochrane Separators

to protect them against damage from water brought over from the boiler or condensed in the steam line, and **to remove from the steam the constant small percentage of water** which is always present unless the steam is superheated, and sometimes even then, since it is a well-known fact that water will flow along the bottom of a pipe containing superheated steam.

By keeping this water out of the engine, the separator much more than pays for itself day by day, in addition to the protection against damage. Where engines are fed only with dry steam, less cylinder oil is required. In some cases, we have known the amount of oil to be reduced by 33 to 50%, after the installation of Cochrane Separators. The blades of turbines fed with dry steam last much longer than the blades of turbines fed with wet steam.

The steam efficiency of turbines is further greatly increased by supplying only dry steam, since each pound of water in the steam entails the consumption of an extra pound of steam to make up for the friction which the water creates. This has been shown by repeated tests.

Cochrane Receiver Oil Separators should always be installed where the exhaust from reciprocating engines is to be used in low pressure turbines. The receiver capacity equalizes the fluctuations in pressure, and the separator removes from the steam all oil and water, so that the turbine operates at its highest efficiency, unaffected by erosion of the blades or accumulations of grease, and the condensate from the surface condenser is entirely suitable for boiler feeding, and can be used in place of impure raw water.

We also build separators for removing water from compressed air and other gases. Write for a copy of our "*Separator Talks*," and if you have some especially difficult separation problem, submit it to our engineers for solution.

Harrison Safety Boiler Works

17th and Clearfield Sts., Philadelphia, Pa.

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Lunkenheimer Co..... 4
Ohio Blower Co.....103
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Reliance Gauge Column Co...109
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Parson Mfg. Co..... 64
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Beggs & Co., Jas..... 63
Hayden & Derby Mfg. Co..... 77
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Bogart Gas Power Engineering Co. 111
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Buckeye Engine Co.....116
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Hoppes Mfg. Co..... 72
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Power Specialty Co..... 84
Turbo-Blower Co..... 88
Wing Mfg. Co., L. J..... 86

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Richardson-Phenix Co. 93

Feeders, Furnace
Ohio Blower Co.....103

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Burt Mfg. Co..... 18
Elliott Co. 7
Flower Co., W. L..... 93
Richardson-Phenix Co. 93
Robertson & Sons, Jas. L..... 59
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Griscom-Spencer Co..... 69
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Dart Mfg. Co., E. M..... 83
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Ashcroft Mfg. Co..... 77
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Chesterton Co., A. W.....101
Garlock Packing Co..... 9
Jerguson Mfg. Co..... 94
Peerless Rubber Mfg. Co..... 8
Rogers Co., H. A..... 76
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Star Brass Mfg. Co..... 60
Von Kokeritz & Co., R. G., 84

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Star Brass Mfg. Co..... 60

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Ashton Valve Co..... 78
Bristol Co.....4th cover
Ohio Injector Co..... 80
Star Brass Mfg. Co..... 60
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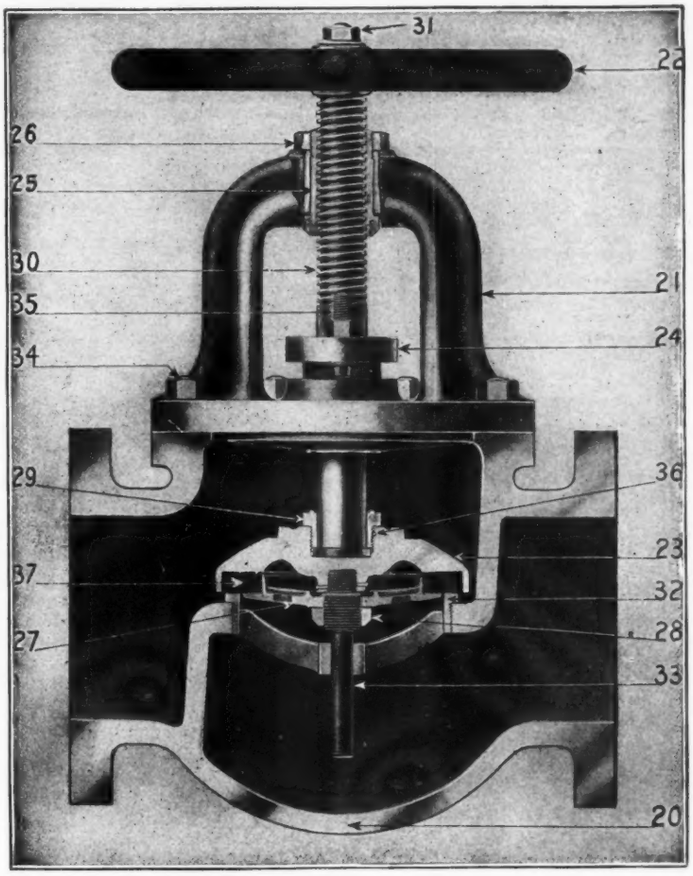
Gages, Vacuum
American Steam Gauge and Valve Mfg. Co.....48 and 49
Schutte & Koerting Co..... 89
Star Brass Mfg. Co..... 60

TRADE JENKINS MARK

Jenkins Bros.

Jenkins Bros. Globe Valves



20. Body
21. Yoke
22. Wheel
23. Disc Holder
24. Gland
25. Yoke Nut
26. Jam Nut
27. Disc Plate
28. Disc Nut
29. Lock Nut
30. Spindle
31. Wheel Nut
32. Seat Ring
33. Guide Stem
34. Yoke Stud
35. Gland Stud
36. Cotter Pin
37. Disc

The above illustration will show you how a Jenkins Bros. Iron Body Globe Valve (Standard Pattern) is made with exactness—how each part is made accurately to fit in with each other part, making a valve that can be guaranteed to keep tight.

Note that the yokes are wide, giving easy access to the stuffing boxes, which can be packed under full pressure when the valve is wide open. These Valves are furnished either screwed or flanged, all sizes, $\frac{3}{4}$ in. to 12 in. and flanged up to 24 inches.

And, remember, although the illustration doesn't show it, the Jenkins Bros. trade-mark is on this valve. It's the trade-mark to look for if you want four-square satisfaction.

You'll find Jenkins Bros. products at your dealers. But if he can't supply you write us for the name of nearest dealer who can supply you. Also write for our latest catalog.

Jenkins Bros.

80 White St., New York 35 High St., Boston 133 N. 7th St., Philadelphia 300 West Lake St., Chicago

Gages, Water
American Steam Gauge and Valve Mfg. Co.....48 and 49
Greene, Tweed & Co., 90 and 4th cover
Huyette Co., Paul B..... 74
Jenkins Bros..... 53
Jerguson Mfg. Co..... 94
Lunkenheimer Co..... 4
Ohio Blower Co.....103
Ohio Brass Co..... 81
Reliance Gauge Column Co...109
Star Brass Mfg. Co..... 60
Wright Mfg. Co..... 74

Gas Exhausters
Ohio Blower Co.....103

Gas Producers
Bogart Gas Power Engineering Co. 111
Du Bois Iron Works.....110
Foos Gas Engine Co.....111
Griscom-Spencer Co..... 69
Minneapolis Steel & Mchy. Co.111

Gaskets
Akron Metallic Gasket Co.... 86
Diamond Rubber Co..... 84
Garlock Packing Co..... 9
Goetze Gasket & Packing Co.. 85
Greene, Tweed & Co., 90 and 4th cover
Jenkins Bros..... 53
Johns-Manville Co., H. W..61, 65
Keeler Co., E.....100
McCord Mfg. Co..... 73
New York Belting & Packing Co. 12
Peerless Rubber Mfg. Co..... 8

Gears
New Process Raw Hide Co... 96

Generating Sets
Foos Gas Engine Co.....111
Fort Wayne Electric Works.. 88

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Elliott Co. 7
Mason Regulator Co..... 76
Northern Equipment Co..... 90
"S-C" Regulator Co..... 83
Squires Co., C. E..... 72
Watson & McDaniel Co..... 97
Ziermore Regulator Co.....102

Governors, Pump Speed
Mason Regulator Co..... 76
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Beggs & Co. 63
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Cyclone Grate Bar Co..... 87
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McClave-Brooks Co..... 14
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Mellor Furnace Engr. Co..... 102
Neemes Bros..... 87
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Dearborn Drug & Chemical Works 5
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N. Y. & N. J. Lub. Co..... 92
Royersford Fdry. & Mach. Co. 95
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Beggs & Co. 63
Blake & Knowles Steam Pump Works 68
Casey-Hedges Co.....101
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Griscom-Spencer Co..... 69
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Hoppes Mfg. Co..... 72
Minneapolis Steel & Mchy. Co.111
National Pipe Bending Co.... 68
Open Coil Heater & Purifier Co. 72
Patterson & Co., Frank L.... 67
Robertson & Sons, Jas. L..... 59
Wheeler Mfg. Co., C. H..... 97
Whitlock Coil Pipe Co..... 68
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Lagonda Mfg. Co.....3d cover
Liberty Mfg. Co..... 7
New York Belting & Packing Co. 12
Peerless Rubber Mfg. Co..... 8

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Vogt Machine Co.....100
Watts-Campbell Co.....115

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Star Brass Mfg. Co..... 60

Indicators, Combustion Engine
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Ashcroft Mfg. Co..... 77
Star Brass Mfg. Co..... 60
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Hayden & Derby Mfg. Co.... 77
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Penberthy Injector Co..... 13
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Flower Co., Walter L..... 93
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McCord Mfg. Co..... 73
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New York Belting & Packing Co 12
Peerless Rubber Mfg. Co.... 8

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Lunkenheimer Co..... 4
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Star Brass Mfg. Co..... 60
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Parson Mfg. Co..... 64

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Burt Mfg. Co..... 18
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Burt Mfg. Co..... 18
Detroit Lubricator Co..... 92
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Dearborn Drug & Chemical Works 5
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Cancos Mfg. Co..... 84
Chesterton Co., A. W.....101
Diamond Rubber Co..... 84
Eureka Packing Co..... 58
Garlock Packing Co..... 9
Goetze Gasket & Packing Co.. 85
Greene, Tweed & Co.. 90 and 4th cover
Jenkins Bros..... 53
Johns-Manville Co., H. W..61, 65
New York Belting & Packing Co. 12
Peerless Rubber Mfg. Co.... 8
Smooth-On Mfg. Co..... 6
Thermoid Rubber Co..... 11
Von Kokeritz & Co., R. G.... 84
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Johns-Manville Co., H. W..61, 65
Von Kokeritz & Co., R. G.... 84
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Bowers Rubber Co..... 88
Cancos Mfg. Co..... 84
Chesterton Co., A. W.....101
Diamond Rubber Co..... 84
Eureka Packing Co..... 58
Flower Co., W. L..... 93
Garlock Packing Co..... 9
Goetze Gasket & Packing Co.. 85
Greene, Tweed & Co.. 90 and 4th cover
Johns-Manville Co., H. W..61, 65
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Peerless Rubber Mfg. Co..... 8
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Armstrong Mfg. Co..... 83
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Wheeler Mfg. Co., C. H..... 97

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Allis-Chalmers Co..... 90
American Well Works..... 99
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Cameron Steam Pump Wks., A. S..... 97
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American Well Works..... 99
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Cameron Steam Pump Wks., A. S..... 97
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Lunkenheimer Co..... 4
Manzel Bros. Co..... 91
Richardson-Phenix Co..... 93
Star Brass Mfg. Co..... 60

Pumps, Oil Force-feed
Deane Steam Pump Co., 1st cover
Detroit Lubricator Co..... 92
Lunkenheimer Co..... 4
Richardson-Phenix Co..... 95

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Pumps, Power
American Well Works..... 99
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Deming Co..... 92
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Quimby, Inc., Wm. E...4th cover
Union Steam Pump Co..... 98
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Quimby, Inc., Wm. E...4th cover